Proceedings

# FUTURES IN WATER

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# Foreword

Concerns over predicted lower Great Lakes levels—due to increasing consumption and possible demands for diversions to drier areas—are growing in Ontario. Increasingly, we Ontarians are realizing the need to conserve water in the Great Lakes and elsewhere in the province.

The *Futures in Water* conference, held in Toronto on June 12-14, 1984 and hosted by the Ontario government, provided a forum for the full spectrum of views on the future of water resources in mid-North America. It was the first international conference on water quantity ever held in Ontario. Men and women from across North America—including politicians, water experts, academics, engineers and representatives from industry, electrical utilities, commercial shipping and conservation groups—attended *Futures in Water*. The sessions dealt with a wide range of international, political, scientific, legal, environmental and public interest group concerns.

Conference topics included: the adverse impact that lower Great Lakes levels would have on the economy and environment; basin-wide management strategies to reduce consumptive losses and fight diversions; learning to treat water as a commodity rather than as a free good; the likelihood that water-short parts of North America will need large-scale diversions to meet their growing water needs; and possible future water level reductions brought on by the greenhouse effect.

We view the conference as an important first step in establishing a continuing dialogue with the public and the various governments and organizations involved in managing the Great Lakes. We must learn to regard our great water heritage as a valuable commodity "future". Together we will work to find common approaches and solutions to our many water quantity concerns.

William Davis

**William G. Davis**
*Premier of Ontario*

Alan Pope

**Alan W. Pope**
*Minister of Natural Resources*

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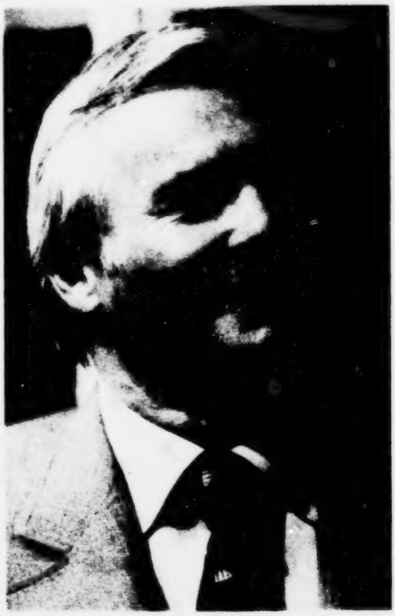
# The Honourable William G. Davis

*Premier of Ontario and President of the Council*

## Welcome Address



*Mr. Davis graduated from the University of Toronto, and Osgoode Hall, and was called to the Bar in 1955. Four years later, he became a member of the Legislature. He was appointed Minister of Education in 1962, and took on the added University Affairs portfolio in 1964. Under his guidance, Ontario's education system underwent major change, including the creation of Ontario's Institute for Studies in Education. In 1971, he became Premier of Ontario, setting his own style through a complete reorganization of government structures. During his Premiership, technological initiatives, the key to future prosperity, have been fostered. In recent years, the Urban Transportation Development Corporation and centres dealing with robotics, biotechnology and computer applications to manufacturing have been initiated. In 1982, Mr. Davis was sworn in as a member of the Privy Council by Her Majesty Queen Elizabeth.*

It is a great pleasure for me to welcome all of you to "Futures in Water".

I am delighted that we have such an impressive group of delegates here from across Canada and the United States.

We are honoured to have among us a wide-ranging group of concerned politicians, water authorities, academics and engineers as well as representatives from industry, electrical utilities, commercial shipping and conservation groups.

I would particularly like to welcome Utah Governor Scott Matheson, Minnesota Senator Dave Durenberger, the U.S. Ambassador to Canada, Paul Robinson, the Minister responsible for Canadian Intergovernmental Affairs from the Province of Quebec, Pierre-Marc Johnson, former Michigan Governor William Milliken of the Center for the Great Lakes, the Canadian Chairman of the International Joint Commission, Blair Seaborn, and his American counterpart Robert McEwen.

No doubt, with the knowledgeable men and women we have together at "Futures in Water", the next two days are sure to be lively and informative. And we are sure to hear many different points of view on this crucial issue.

Many of you may not realize this, but you are all part of a historic conference.

After all, this is the first time in Ontario, and I believe the first time in Canada, that an international conference on water *quantity* has been held.

When our children and our grandchildren look back on this conference in the years to come, I hope they will see "Futures in Water" as an event that paved the way to greater awareness and appreciation and ultimately improved water management on both sides of the border.

Besides being part of an extremely significant conference, I'm sure many of you know that you are here at a time when all of Ontario is celebrating an important historical anniversary—our bicentennial.

We are celebrating the arrival, 200 years ago, of the first United Empire Loyalist settlers. As you know, many of the United Empire Loyalists migrated north to Canada during and after the American Revolution because they wanted to remain under British rule.

No doubt some of those early settlers would be surprised if they could see us now, Canadians and Americans sitting together, discussing how best to manage the Great Lakes and our other water resources.

After all, it was only 150 years ago that we fought for control of the Great Lakes. And to show for it we have two 1812 American warships, the Scourge and the Hamilton, sitting on the bottom of Lake Ontario, attracting a great deal of interest on both sides of the border.

As we look back over Ontario's past 200 years, it's not difficult to see the importance water has played in the growth and development of our Province. I'm sure the same is true of the various jurisdictions you call home.

In the case of this Province, our extensive waterways attracted and led our earliest explorers and settlers into what was to become Ontario.

They settled along the shores of the Great Lakes and other bodies of water throughout the Province, and they depended on these vast freshwater lakes and rivers for their drinking water, for transportation, for trade, as well as for their livelihood: fishing, logging and running their mills.

For example, the picturesque Credit River, which flows into Lake Ontario just west of here, was the focus for much of the early settlement in Southern Ontario, including my own home town of Brampton.

I'd like to read you something that our first Governor, John Graves Simcoe, wrote in a despatch to England when proposing that a colony be established here in the late 1700s.

He wrote and I quote: "For the purpose of commerce, union and power, I propose that the site of the colony be in that great peninsula between the Lakes Huron, Erie and Ontario, a spot destined by nature, sooner or later, to govern that interior world."

Well, I don't know if our sister Provinces would necessarily agree with the statement that Ontario, by virtue of its water resources, was destined to exert a great deal of influence on the rest of Canada.

But there's certainly no question that Ontario has become the most populated and the most industrialized Province in Canada because of our advantageous location on both the Great Lakes and the St. Lawrence Seaway.

Indeed,water is the lifeblood of this Province and the entire Great Lakes Region.

Yet it is only recently that we have begun to realize that our rich water resources could be reduced by growing demands for water on both sides of the border.

Recently, we were all somewhat startled to learn, from a report prepared for the International Joint Commission, that projected water levels on the Great Lakes could drop up to 13 inches within 50 years simply because of growing demand in Ontario and the Great Lakes states.

And we, in Ontario, are becoming increasingly aware of growing pressures in the water-short states of the American midwest and southwest and of their desire to tap in to the Great Lakes to augment their water supplies.

Of course, it's a basic law of economics and of human nature that you don't realize how valuable something is until it is endangered or until someone else wants it.

And that awareness is just beginning to take hold in Ontario. The I.J.C. report and growing pressures for Great Lakes water in the United States have jarred us into taking stock of our water recources and recognizing the necessity of mapping out a water strategy for the future.

However, the most immediate problem the Ontario Government faces is convincing the people of Ontario that water quantity is indeed something we should all be deeply concerned about.

We have never really had to worry about water quantity in this Province before. Quality yes, but not quantity.

After all, Ontario is blessed with some of the finest water resources in the world.

From the Great Lakes and the St. Lawrence River in the South to James Bay and Hudson Bay in the North, and the hundreds of thousands of lakes and rivers in between, there's no question that water is one of Ontario's greatest resources.

As a matter of fact, even the name given to this Province recognizes that fact since it means "sparkling waters".

In a Province so rich in this most valuable resource, it is hard for most of us to appreciate the fact that our supply of water is not limitless. It is hard to imagine the levels of the Great Lakes dropping permanently, with the attendant economic and environmental havoc.

And yet this could be the reality. That is why the Ontario Government decided to host this conference. I think the time has come when the people of Ontario and, indeed, many others on both sides of the border, must be fully informed of all aspects of the emerging water consumption and diversion issues.

We must begin to map our future water strategies today, and we can best do this with the support of a well-informed and concerned public.

It's true we don't have a problem now. However, we must take the opportunity to plan for the future, to ensure that we make the best decisions today, and to safeguard and conserve our water for tomorrow.

The opinions and knowledge each of you brings to "Futures in Water" will enrich our understanding of these emerging issues.

This is, of course, indicative of the scope and importance of the water quantity debate. It also reflects that water is not confined to Provincial, State or even National boundaries.

Take the Great Lakes as an example. I'm sure many Ontario residents view these vast bodies of water as being solely Canadian. And I wouldn't be surprised if many of our American neighbours also saw the Great Lakes as being solely American.

In fact, one of the Great Lakes, Lake Michigan, lies entirely within the U.S.

The fact of the matter, however, is that the Canada/U.S. boundary runs through the centre of Lakes Superior, Huron, Erie and Ontario, as well as the St. Lawrence River.

That same border, and the peace and harmony that have reached across it in both directions, represents, in and of itself, many of the best aspects of the Canadian-American relationship.

That international boundary is not a brick wall in any sense at all, particularly when it comes to water. If water is taken out of the Great Lakes on the Canadian side, it is missed downstream on both the American and Canadian sides.

The same applies to water removed from Lake Michigan. Water permanently removed from that lake is also missed downstream, by both Canadians and Americans.

I know that those of you from the Great Lakes states are equally concerned and alarmed about the potentially devastating impact of increasing water consumption and diversions from the Great Lakes.

Exactly two years ago, at the Great Lakes Water Resources Conference in Mackinac Island, Michigan, I participated with the Great Lakes Governors in passing a resolution that stated we were opposed to any more diversions out of the Great Lakes.

Since that time, we have worked together to strengthen the spirit of regional co-operation and improve our understanding of these water quantity issues.

The presence here today of many representatives from the Great Lakes states is another sign of this willingness and, indeed, desire to continue to work together to plan for the future.

I am equally delighted that we have with us a great number of respected water authorities from outside the Great Lakes basin. I appreciate your coming all this way to share with us your knowledge and your unique perceptions on the future of Canadian and American water resources.

One of the speakers, Ambassador Paul Robinson, recently said that Canada and the United States are moving into one of the most co-operative periods in recent history.

One only has to look around this room to see how true that statement is.

I am gratified by this spirit of growing international co-operation, particularly since the future of our joint water resources is a matter that affects all of us, on both sides of the border.

I look forward to hearing all of your comments and concerns about the future of our water resources.

As I said earlier, the more we learn today about the emerging issues of water consumption and diversion, the better equipped we in Ontario will be to make the right decisions, to that together we can ensure that this rich heritage is protected and conserved for many years to come.

## William G. Milliken

*Former Governor of Michigan*
*Chairman of the Board, Centre for the Great Lakes*

# Impacts of the Great Lakes on the Regional Economy

*Born in Traverse City, Michigan, Mr. Milliken is a graduate of Yale University and a former President of J.W. Milliken, Inc., a department store chain.*

*He entered politics and served as Governor of Michigan for a record fourteen years, 1969 through 1983. Among many conference activities, he has been Chairman of the Upper Great Lakes Regional Commission and President of the Council of State Governments.*

*An outstanding conservationist, he received the Michigan United Conservation Clubs' Conservationist of the Year (1978) and a Special Conservation Awarded from the National Wildlife Federation in 1979.*

*Following the 1972 Water Quality Agreement between the United States and Canada, he again hosted a conference of Great Lakes Governors and Premiers which set an agenda for the Great Lakes for the decade of the eighties concerning issues of navigation, diversion threats and improved water quality.*

Good morning. I want to thank Premier Davis for inviting me here and for giving me this opportunity to speak to you this morning. I've enjoyed working with the Premier over the years and hope to have more opportunities to work with him in my new capacity as Chairman of the Board of the Center for the Great Lakes.

As you know, the Center was established last year as a private, non-profit binational organization to contribute to the development and implementation of public policies toward the lakes. It aims to be a resource for decision makers like those of you here today and to create a forum for discussion and action by the various groups and individuals who have already worked long and hard and who continue to work to develop an agenda for the region's future.

All of us here today are aware of the many ways the Great Lakes affect our regional climate, helping to produce one of the world's richest natural agricultural belts, providing balmy breezes in summer to lakefront cities and resort communities and, in winter, helping to produce that fine white powder, which we in the Water Belt know as snow, for the region's ski resorts.

We have gathered at this conference, however, to talk about another kind of lake effect: the substantial impacts, past, present and future, of the Great Lakes on the regional economy.

Centuries before Europeans arrived, these lakes which we now think of as "ours" were important links in trade routes developed by the native dwellers on our continent. They were later essential to the success of the fur trade, to the opening up of the wilderness for settlement, and to the export of timber, iron ore, grain and other raw materials from a thriving yong heartland.

The industrial revolution intensified the importance of water to successful commerce and, by the middle of this century, we were not only growing half of the continent's food but also producing 2/3 of its iron and steel, more than half of its automobile and machine parts, and more than a quarter of its chemicals. To transport these goods, the region boasted one of the best rail, shipping and highway transportation networks in the nation.

New industrial growth has, in the last several years, shifted to southern and western regions of the United States as local and state governments in those areas, hungry for a bigger share of our prosperity, offered strong incentives and, as a global recession, changes in consumer habits, and other factors affected the industries which stayed.

Signs of a turnaround are already evident, and I believe that water once again is going to be the key.

We see or hear reports in the media almost every day now about the problems that water shortages can cause.

They are enough to make me realize how very fortunate we are to have this magnificent freshwater resource at our doorstep. We have only to step outside here at the Harbour Castle Hilton to take in a view that is at once beautiful, invigorating and reassuring.

As Ralph Waldo Emerson once wrote: "The health of the eye demands a horizon. We are never tired, so long as we see far enough."

The lakes that support our economy also renew our spirit.

The developers of some new housing projects in the Southwest are inserting clauses in their buyers' contracts which say that water supply on the property cannot be guaranteed over a 100-year period.

The Ogallala aquifer, a groundwater reserve which spreads over 3,200 square miles beneath eight west central states, is running dry from heavy irrigation at such a rapid rate that the United States Internal Revenue Service grants farmers there a depletion allowance on their wells, similar to the tax allowance granted to oil drillers.

Each year, those farmers pump water at 50 times the aquifer's recharge rate, more than the entire flow of the Colorado River. Optimists give the Ogallala a life expectancy of 40 years; pessimists give it 8.

In parts of Arizona, the water table has sunk 400 feet in the last 50 years. Between Phoenix and Tucson, an earthquake-like trench 120 miles long and 20 feet deep in spots has opened up as the ground has settled from withdrawals of surface water.

California's San Joaquin Valley has dropped nearly 30 feet in some places. The compacted soil there, according to experts, has lost its capacity to hold water, so that even if pumping stopped, the aquifer underlying the valley could never recharge.

It is no longer possible for the people who live and work in these parched areas to remain "sunblind" any longer to the limits of their own growth. The idea of exporting Great Lakes water is being discussed in those regions more seriously than before.

In reacting to such ideas, we must realize that not only is the Great Lakes system itself linked in many ways; the region's water-dependent economy is also interconnected.

We know that natural changes in lake levels can affect the economy, whether those levels are excessively high or low. But the I.J.C. has estimated that the effects of even a moderate-sized additional diversion of Great Lakes water, say 5,000 cubic feet a second, could by a series of chain reactions, cost $53 million in damage in a single year to Great Lakes fishing, shipping, utilities, tourism, recreation and water-intensive industries.

To cite a few examples:

Shipping experts estimate that each inch of reduction in the levels of the lakes below the 27-foot navigation level costs the industry $2.5 million.

Hydro-power experts say each inch of reduction costs $10 million in hydro-power loss.

And fish, wildlife and recreation experts claim that each inch of reduction in lake levels costs the recreation industry between $3 million and $12 million, mainly in loss of spawning grounds, but also in the necessity to move boat docks and perform other such chores.

The costs of large-scale diversions, over a long period, are harder to calculate. But I think it's safe to say that to divert water would also be to give up one of the major advantages over other regions which we can now offer with confidence, the ability to provide reliable, clean water in great abundance, without reliance on hundreds of miles of pipelines, millions of federal dollars, and erratic rainfall.

Putting it more simply, to export water is to export jobs.

Many of us in the region have noted before, as I will note today, that it is much more sensible and cost-efficient, in the face of natural limitations on this irreplaceable resource, to bring people to water rather than transporting water long distances to attract people.

Arizona's Governor Bruce Babbit noted recently that the Central Arizona project, a massive undertaking which proposes spending $3.5 billion of federal money to run water 1,200 feet uphill over a distance of 330 miles, was conceived as a reclamation project to serve rural needs but that, when finished, it will serve a population which is largely urban.

Meanwhile, our Great Lakes water is becoming more valuable in new ways and for yet another reason.

The improvements in water quality, improvements which began with the Great Lakes Water Quality Agreement and which many of you in this room today played a part in producing, are starting to pay off in economic terms, too.

A new report from the Center for the Great Lakes, prepared for our Council of Great Lakes Governors, documents a number of ways in which the high quality of Great Lakes water, which is readily and abundantly available, is a strong but often underestimated economic asset.

Lake Erie, for instance, a body of water for which many people were writing premature obituaries just over a decade ago, is now being used as part of a broad quality-of-life appeal developed by the City of Cleveland to attract corporate headquarters and service or type industries. The appeal has been so successful that executives of some of the newly recruited companies are now volunteering to go on the road to lecture other potential investors in the city.

In Holland, Michigan, on the eastern shore of Lake Michigan, lakeshore beaches and a spectacular spring display of tulips have been combined in a unique marketing push which has produced a 25 per cent hike a local income from a 3 per cent growth in population over the last three years.

Kingston, Ontario, following its experience of serving as host to sailboat competitions during the Montreal Expo some years back, has managed to attract multi-million dollar businesses by hosting dozens of regattas each year and promoting itself as "the sailboat capital of the world".

Water quality improvements have played a part in the region's still-growing tourism industry, currently valued at $15 billion per year.

Water quality is also essential to the success of sport and commercial fisheries.

According to the Great Lakes Fishery Commission, anglers from the eight Great Lakes states and Ontario spend $755 million a year, a substantial return on government investments of $40 million.

As the money changes hands, the impacts on state, provincial and local economies grow to well over a billion dollars.

In just one town, the tiny hamlet of Pulaski in upstate New York, the installation of a state fish hatchery on the Salmon River which empties into Lake Ontario created more than 300 jobs. And the town's economy was increased tenfold in the last decade.

Meanwhile, people in the water-based industries which have historically provided our strongest base, industries like steel and food processing and timber products, are indicating that clean, abundant Great Lakes water is in some ways more vaulable to them than ever before.

An executive of a steel company on Indiana's Lake Michigan shore, for instance, explained that while new recycling requirements make water quantity less relevant in business location decisions, it has made water quality more important.

Because the Great Lakes are lower in rust-producing dissolved salts, minerals and other impurities than well or stream water, plants located on the lakes may save more than $1 million a year on equipment maintenance, chemical applications used to remove impurities, and parts replacement.

And a site manager for a paper mill, which has doubled its capacity three times in the past 10 years, said the clarity in nearshore areas of the Great Lakes, much improved since the institution of phosphate bans and improvements in municipal sewage treatment, also saves dollars.

Water must pass directly over the paper during the manufacturing process, he said, and impurities could stain the paper.

The state of Michigan is currently using Lake Michigan water in a marketing push to attract new paper and pulp mills.

Finally, I would like to repeat my conviction that we have a resource on our hands that we cannot afford to squander. Laying aside our internal differences, our intra-regional rivalries, we must act together to protect and nourish our Great Lakes as they have protected and nourished us, for they are the key that will ensure a healthy and prosperous future for us all.

## Scott M. Matheson

*Governor of Utah*

# The Sharing of Water on a Continental Basis

*An honour graduate in Political Science from the University of Utah, Governor Matheson took his law degree from Stanford University in 1952. He has been Solicitor General for the Union Pacific Railroad and also Assistant General Counsel for Anaconda Company.*

*In 1968-69, he became the youngest President of the Utah State Bar and in 1975 was Vice-President of the Utah Bar Association. Elected Governor of Utah in 1976, he served as first Chairman of the N.G.A. Sub-committee on Water Management from 1979-1982, and was one of four Governors on the Intergovernmental Task Force on Water Policy. He then became Chairman of the National Governors' Association in 1982-83. President Reagan named him to the Advisory Council on Intergovernmental Affairs in 1983.*

I was pleased to accept the invitation of Premier Davis to participate in this important conference.

As governor of one of the most arid of the United States, I spend a great deal of my time discussing, and I hope in some small part influencing, the "Futures in Water" as they relate to my state and my region. And I bring a perspective based upon that environment.

I have been specifically asked to address the topic of the sharing of water on a continental basis and the likelihood of such arrangements in the future.

In his letter, Premier Davis underscored the sensitive nature of this topic. Not only have political fortunes been lost but, blood has been shed over the allocation of what I consider to be our most important natural resource. Nevertheless, it is an appropriate subject for discussion as we look to the future. In my opinion, we should initially seek to establish a mutual understanding of the water situation in the West, the prevailing doctrines of western water law, and the viability of alternative means of meeting the increasing demands on this limited resource before we seriously discuss sharing water on a continental basis.

I live in the West where drought is the normal condition of the environment. An area of over one million square miles receives less than twenty inches of precipitation a year. Along the 100th meridian, the Great Plains average ten to twenty inches a year. Vast sections of Idaho, Wyoming, Utah and Arizona average less than eight inches.

Phoenix, Denver, Albuquerque and Salt Lake City have developed in areas where fifteen inches of precipitation or less is the norm. By contrast, the eastern United States averages forty-four inches per year.[1]

Despite the lack of abundant water resources, the West continues to grow in population and economic development. The challenge to provide water for these growing needs is magnified by the fact that approximately 70 per cent of western streamflow originates from winter snowpack which melts and results in rapid runnoff during May, June and July. Furthermore, the total amount of water available from year to year varies more in western rivers than in eastern rivers. This, of course, is why we have built dams to capture the spring runoff and conserve it for subsequent use. The Bureau of Reclamation, the federal agency charged back in 1902 with reclaiming the lands of the arid west, has constructed 313 such storage dams, 7,020 miles of canals, 134 pumping plants and 50 hydro-electric plants.[2]

At the same time, westerners have utilized groundwater resources to supplement surface flows. But given the relatively small amount of precipitation in the west, groundwater has often been used in excess of nature's ability to replenish it. Consequently, some states are experiencing the problems associated with the overuse of groundwater, including land subsidence, salt water intrusion, increased contamination and increased pumping costs. In 1949, about 2 million acres in the High Plains were irrigated by 4 million acre feet of groundwater. By 1980, about 170,000 wells pumped 18 million acre feet of water to irrigate 13 million acres. The withdrawals from storage in the southern and central High Plains have been accompanied by widespread declines in water level, to the point that the Ogallala aquifer has been dewatered by more than 50 per cent in over 3,500 square miles in Kansas, New Mexico and Texas.[3] Most of this water, and, indeed, most of the water in the western United States, is used for agricultural production, providing for a truly world class industry. Nevertheless, the overdraft occurring in the Ogallala Aquifer and in many other parts of the West, cannot continue indefinitely.

The scarcity of the resource and the need for certainty in its use led to the development of the appropriation doctrine, which is the prevailing rule of water law in the West. An understanding of this doctrine helps us to better evaluate what alternatives are available for western water managers and policy makers in light of increasing demands on the resource.

Early miners in the western United States often needed water to extract minerals located far from natural water resources. They constructed diversionary and transport devices to facilitate their water use. If a miner was the first to put the water to use, then that miner acquired the highest priority to utilize the resource. In such circumstances, the miner was entitled to fully utilize the water right to the exclusion of all subsequent claims, if necessary. The same rule applied for the user who was next in time, as against all subsequent users.

Congress approved this practice in various federal statutes designed to encourage public settlement in the West. It has subsequently been codified in the statutes of every western state. It can clearly be said that the appropriation doctrine has greatly contributed to the stability necessary for making the West inhabitable and economically productive.

Appropriate water rights are private property interests entitled to constitutional protection. Such rights may be bought and sold, subject to the requirement that they be put to publicly defined beneficial uses and that any transfers not injure other appropriators. During times of scarcity, senior water rights are completely protected to the extent of the available supply. Junior rights holders receive water only after full satisfaction of all of those holding senior rights.

Thus, the appropriation doctrine protects development and expenditures incurred in reliance on utilization of water, and establishes a clear hierarchy in times of water shortages. The doctrine also facilitates the establishment of rights to use water at substantial distances from the sources of supply. As a rule, water diverted under such circumstances is utilized within the river basin of its origin. However, utilization outside the basin has also occurred in many instances.

The earliest interbasin water use in an appropriation state occurred when the Los Angeles Aquaduct was built in 1913. It initially carried approximately 150,000 acre feet per year from the Owens Valley on the eastern slopes of the Sierra Nevada to the Los Angeles Valley. The aqueduct expanded to deliver a total of 472,000 acre feet annually. Other interbasin transfers in California play an integral part in the state's Central Valley Project.

Such transfers are also important in Colorado. The Colorado Big Thompson Project collects water in the Upper Colorado River Basin and carries it via the Adams tunnel to tributaries of the South Platte River as supplemental water for irrigation of 615,000 acres in Eastern Colorado. Recently, much of this water is being used for domestic, municipal and other non-irrigation purposes.

In my home state of Utah, we are implementing a diversion plan which includes interbasin transfers to bring water from the Colorado River to the central portion of Utah on the edge of the Great Basin. This water is critical to the state's overall supply, since no new water development has occurred for almost forty years to serve the state's major population area. The Central Utah Project, designed to accomplish this diversion, will help meet these needs.

The interbasin transfers I have mentioned involved considerable planning, funding, time and effort. They are considered to be monumental in their scope, yet they absoutely pale in comparison to existing proposals for so-called "large-scale" interbasin transfers. By this I refer to diversions which would carry water both from basins of origin and over state and/or international boundaries. Numerous such plans exist. There are many examples.

(1) *The Snake-Colorado Project.* This project would divert some 2.4 million acre feet of water from the Snake River near Hagerman in southern Idaho and deliver it via aqueduct to Lake Mead on the border of southern Nevada and Arizona.

(2) *The Western Water Project.* This proposal would divert 15 million acre feet annually from the Columbia River above The Dalles to Lake Mead. The proposed route would require pumping water to an elevation of 4900 feet in order to traverse mountain divides.[5]

(3) *The Grand Replenishment and Northern Development (GRAND) Canal.* This plan involves collection and diversion of runoff from the James Bay Watershed into the Great Lakes for purposes of water level and quality control, and power production. Initially, approximately 17 million acre feet per year of Canadian water would be transferred for use in both Canada and the United States.

(4) *North American Water and Power Alliance (NAWAPA) System*.
This is the largest of all proposed large-scale transfer plans. It contemplates a series of projects over a period of time which would: provide water to seven provinces of Canada, thirty-three states in the United States and three northern states of Mexico . . . initially diverting 110 million acre feet . . . produce 70 million kilowatts of electricity per year . . . and add 40 million acre feet annually to the Great Lakes.[6]

The intent of the proponents of these interbasin plans is to provide for increased development and economic well-being by means of water transfers. But, as you know, many significant problems are inherent in such large-scale plans. One is that few technical, site specific engineering feasibility studies have been performed. One often reads that a certain plan would require a certain number of miles of canals, a certain distance of pumplift, or a specified number of kilowatts of electricity. Yet, one rarely finds the comprehensive technical information to accompany these numbers.

The "political" constraints associated with the sharing of water on a continental basis are incredibly complex. Some observers view water as a commodity to be bartered like bushels of wheat. A number have forgotten the difficulties involved in transportation. Others have neglected the water needs of the areas of origin. Little in-depth study has been given to the intergovernmental arrangements that must precede large-scale transfers. These relate not only to the acquisition of water, but also to obtaining the rights of way. Also, few, if any, comprehensive studies exist on how affected citizens view large-scale transfer plans.

I do not wish to intimate or suggest that continental water sharing is a political impossiblity. However, it seems to me that the political aspects of international and interstate water sharing have been largely overlooked. For example, there exists, as a matter of United States law, a moratorium on any study by a federal agency of schemes to supplement the flow of the Colorado River by importation from other basins. This moratorium began in 1968 and, through re-enactment, will run until 1988. Thus, Congress has largely precluded the normal process of reviewing political and other considerations relating to water importation to the most arid part of the United States. Also of note, most of the individual United States have laws restricting out-of-state and/or out-of-basin water transfers. Although the recent United States Supreme Court decision in *Sporhase vs. Nebraska*[7] eroded some of these restrictions, many remain.

Much has been written about the benefits of creating "new supplies" of water through interbasin transfers. Yet, when all social and economic concerns are weighed, one must question whether overall benefits outweigh the costs. They include economic effects on the exporting region, environmental impacts and possible disruption of the socio-economic patterns of the area of importation. If the benefits are primarily agricultural, the effect of additional goods to national and international markets on the price of goods already produced must be considered. In short, tremendous socio-economic ramifications are inherent consequences of any large-scale interbasin transfer These consequences need to be given much more consideration

Given the costs of such large construction projects and the associated impacts that would result, western water planners do not view such proposed transfers as a viable alternative to meeting water needs in the foreseeable future.

So, what must the West do to meet the ever-increasing needs of our cities and our farms to provide for industrial development and environmental enhancement? Allow me to suggest some alternatives.

One alternative which readily suggests itself is to make more efficient use of existing supplies.

Water conservation is an important component of western water management. Western water law explicitly prohibits waste and defines the quantity to which a water right holder is entitled by reference to a specified beneficial use. Every user owes his return flows to the river where the water may be reused.

State water resource managers must continue to examine situations where more effective implementation of these measures would be beneficial. There are some indications that the potential benefits are significant. The U.S. Department of Interior analyzed potential savings on 61 existing irrigation projects. They estimated that .7 million acre feet of water is currently lost to any beneficial use on thes projects.[8]

I must add, however, that water conservation offers no panacea to meeting all of the water needs of the West. In the first place, water conservation and water savings are not necessarily synonymous. Due to the nature of the hydrologic cycle, water which might appear to be wasted and lost returns to surface streams and groundwater reservoirs where it is again available for use. Indiscriminate application of conservation practices, without adequate analysis of the effects, can reduce recharge to groundwater systems, lower water tables, reduce marshy wildlife habitat, increase energy consumption, disrupt patterns of reuse in the river system, and produce many other undesirable effects.[9]

Conservation is a tool to be used as any other tool where it increases desired benefits without adversely affecting other important values.

Additional storage facilites also represent an alternative for enhancing water supplies in the West. Such facilities have helped transform the West, and now the needs of millions of people for water for irrigation, hydro-electric power, homes and factories, outdoor recreation and other related use.

However, it seems clear that the great dam building days are largely over. After completion of those projects currently under construction, most of the major feasible dam sites will have been taken. Moreover, the substantial financial commitments required for such large multi-purpose projects are less likely to be forthcoming in today's climate of federal fiscal austerity. Nevertheless, smaller supply projects will continue to be necessary if we are to provide future generations with a dependable supply of water. In this regard, I believe that state governments will need to take an even more active role in the planning and financing of such projects.

I refer to "an even greater role" because state and local governments have traditionally borne the greater burden of financing natural water resource development. The only comprehensive estimate of total historical expenditures appears to be in the National Water Commission Report of 1973.[10] The Commission estimated these expenditures at roughly $338.6 billion. State and local expenditures accounted for 57 per cent of the total, federal expenditures for 26 per cent, and private expenditures for the remaining 17 per cent. My state and every other western state with which I am familiar has an active program for financing water projects. For example, during my years as Governor, we have invested $75 million in a revolving loan fund to finance small and medium-sized water projects. These projects have provided important additions to Utah's agricultural, municipal and industrial water supplies. Moreover, western governors are presently engaged in looking at new and innovative ways by which states may increase their role in water project financing. I support this endeavour.

I should add, however, that I do not support federal abdication of responsibility for water resource development where an appropriate federal interest is involved. Recognizing that there are constraints on the federal treasury, the federal government is nevertheless often in the best position to finance water projects. Where important water resource development needs cannot be otherwise met, the federal government should finance such projects and subsequently recover associated costs from direct and indirect project beneficiaries over a reasonable repayment period and at an appropriate interest rate. That has been the policy of federal water development in the past, and that policy should continue.

To the extent that we fall short in meeting the increased demands for water in the arid regions of the West, I submit that the immediate result will be the retirement of agricultural lands. Such a process is already underway in central Arizona to curb the substantial overdraft of groundwater occurring in that region. Indeed, it is estimated that there will be virtually no agricultural industry in the central valley of Arizona after the turn of the century.[11]

Cities and industries are clearly in a position to purchase agricultural water rights. State and local governments must decide to what extent laws and policies should accommodate this transfer. The demands on the existing supplies will undoubtedly be a predominate factor in this decision.

But other socio-economic factors must also be considered. Irrigation assures that crops will be available, will be of high quality, and can be sold in stable markets, despite the vagaries of the weather. There is much at stake. In the period from 1973 to 1977, the West provided 55 per cent of the fresh fruits and vegetables marketed in 41 major U.S. cities. Western agriculture provides diversification and long-term stability in contrast to an otherwise typically erratic resource-based economy.[12]

In summary, the challenges are monumental, but not insurmountable. The western states have, for many years, been dealing with the realities of a water short region. State governments in the West cannot rely on federal largesse, particularly on the grandiose scale envisioned in the various schemes to transfer water across the continent. Even if the financing were available, it is doubtful that we would find the economic and environmental consequences acceptable. I submit that, for now, we must continue to pursue other alternatives.

States must be more aggressive in financing needed water projects, while at the same time implementing appropriate measures to utilize existing supplies more efficiently. States will also need to continue to carefully weigh the benefits and costs associated with each competing use of water and area of use in making their determinations as to the use of water in the West. These decisions will shape the priorities for water uses between farmers, cities, industries and competing environmental uses.

It is in these efforts where I propose the sharing on a continental basis, not a sharing of water resources, but of ideas, of information, of understanding. Together we can better meet the challenges that face us. Through conferences like these, I believe that we facilitate the accomplishment of our mutual goals, and the assurance of that future that we desire for our people. Thank you.

[1] *New Challenge, New Direction: The Water Policy Report of the Western Governors' Association*, Western Governors' Association, 1984, p. 7.

[2] *What is Reclamation?*, U.S. Department of the Interior, nd, p. 3

[3] *National Water Summary 1983 – Hydrologic Events and Issues*, United States Geological Survey (Water Supply Paper 2250), 1983, pp. 40-41.

[4] *Interbasin Transfers of Water*, by Charles Howe and William Easter, 1971, p. 6

[5] *Law of Interbasin Transfers*, Ralph W. Johnson, 1971, p. 18.

[6] *Interbasin Tramsfers of Water*, by Charles Howe and William Easter, 1971, p. 17.

[7] *Sporhase et al v. Nebraska*; 103 S.Ct. 3456 (1982).

[8] *Report on the Water Conservation Opportunities Study*, U.S. Department of the Interior, 1978, p. iii.

[9] *Water Conservation and Western Water Resource Management*, Western States Water Council, 1983, pp. 7-12.

[10] *Water Policies for the Future*, National Water Commission, 1973.

[11] *The Nation's Water Resources 1975-2000 (Volume I: Summary)*, Water Resources Council, 1978, p. 56.

[12] *Western State Groundwater Management*, Western States Water Council, 1982, p. 10.

[13] *New Challenge, New Directions: The Water Policy Report of the Western Governors' Association*, Western Governors' Association, 1984, p. 28.

# The Honourable Pierre Marc Johnson

*MNA Minister of Justice and Attorney General, Province of Quebec*

## A Quebec Perspective on the Great Lakes—St. Lawrence River System

*Hugues Morrissette representing The Honourable Pierre Marc Johnson*

*A Political Science graduate from Montreal's College Jean-Brebeuf, Mr. Johnson received his law degree from the University of Montreal in 1970. He entered medicine at the University of Sherbrooke, graduating in 1975, practicing at Saint-Luc and Maisonneuve-Rosemont Hospitals in Montreal. He then entered politics, serving on the National Executive of the Parti Quebecois. Appointed Minister of Labour and Manpower in 1977, he became Minister of Consumer Affairs in 1980. As Minister of Social Affairs in 1981, he was responsible for expanding Quebec's Community Service network. Now Minister of Justice and Attorney-General, he has the Quebec responsibility for Canadian Intergovernmental Affairs.*

Honourable Pierre Marc Johnson was represented by Mr. Hugues Morrissette.

The Minister of Canadian Intergovernmental Affairs, Mr. Pierre Marc Johnson, cannot be with you today. He has asked me to represent him and to express Quebec's interest in the theme of your conference.

In the immense St. Lawrence/Great Lakes System, water management is of vital importance. It is important not only to the states bordering on the system but also to the people who live downstream and who rely on that resource both for their daily life and for their economic development. What you will be discussing here has not yet captured the interest justified by its scope, but it is to be hoped that, through fruitful exchanges at this conference, public opinion will be made more aware of this matter. A conference of this kind is an event. For here, a challenge is being met for the future: the challenge to ensure healthy management of a resource which, inexhaustible though it may be, is no less alterable.

What must come from this meeting is a better understanding of the stakes and interests involved. To this end, what is needed is a spirit of collaboration and joint effort. This forum is a "first" for Canada. Here, all the parameters of the question, and above all the interrelations of those parameters and their impact on human life, may be identified.

In the earliest days, the St. Lawrence/Great Lakes System was the sole access route to the interior of the continent—the cradle—if you like, of North American civilization. This was the route taken by the first settlers. It was also the route by those first discoverers—the Radissons, the Charles Lemoine Desgroseilleres, the La Verendryes, the D'Ibervilles and the others who opened up the west.

From the very earliest days of the colony, the fur trade established the St. Lawrence/Great Lakes System as commercial. This vocation grew with the years and, in time, major industrial and commercial centres rose along its shores: Toronto, Montreal, Detroit, Chicago, etc.

At first, the river was used mainly by coastal freighters supplying the local communities. Then, the Seaway was dredged and developed. This meant that the grain producers of the Prairies and the mid-west, and the industrial centres along the Great Lakes, would have access to the international markets. Ice breakers have been keeping the port of Montreal open all year round.

Now that it has played a supporting role in the development of the heart of North America, the St. Lawrence/Great Lakes System is, to a certain extent, a victim of its own success. Population and industrialization have accelerated since the beginning of the century, and with that acceleration have come effluents: effluents which for too long we thought could be simply piped into any water that happened to be nearby.

At the same time, more water was needed, both for industrial purposes and for drinking. As a result, the quality of our water degenerated to a point where both the supply of water to certain population groups and the economy of those groups were threatened. For the St. Lawrence/Great Lakes Basin constitutes an ecosystem whose balance must be maintained, since all who live along its shores are affected by it. This ecosystem condemns us to interdependence and collaboration: what one group does must not be allowed to inflict irreparable damage on another group and, at the same time, we must all be able to reap the best possible benefits from this resource which belongs to all of us.

Quebec, being downstream, is especially concerned about the decisions which might be taken by the upstream states and provinces.

The Great Lakes/St. Lawrence hydrological system is vital to Quebec, since most of Quebec's population is concentrated on the banks of the river, and about 40% of that population draws its drinking water from the river. The Government of Quebec, then, must concern itself above all else with the quality of that water, since the health of the people of Quebec depends on it.

Moreover, the St. Lawrence River has always been a driving force for the Quebec economy. Navigation and harbour activities have always been essential to our prosperity, but the river also generates investments and jobs in sport and commercial fishing, in recreation and tourism which forms part of Quebec's tradition and heritage, and in the production of hydro-electric power in the Montreal Region.

The Government of Quebec, then, is interested in seeing the joint efforts of the states and provinces bordering on the Great Lakes not just continue, but intensify. Recent studies have shown that the waters of the Great Lakes contain eight hundred various chemical products. Part of this pollution is found in the waters of the St. Lawrence, to a point that our filtration plants can no longer get rid of all of it. We acknowledge the considerable efforts made in recent years toward depolluting the Great Lakes, but let it nevertheless be recorded that we remain concerned about the increased industrial pollution of the Great Lakes, about the excessive amounts of drinking water being drawn for riverside consumers, and about the way in which the problems of water supply in the American midwest are to be resolved.

We know how complex the problems appear from an American perspective: the balance between the interest of the "Water Belt" and the so-called "Parch Belt", the diminishing underground reservoirs with the main one—the Ogallala Aquifer—scheduled to dry up in about 40 years, the maze of federal and state rights, the regional and national interest, to name a few.

While we admit that Quebec bears responsibility for part of the pollution of the St. Lawrence, it must also be acknowledged that the Government of Quebec is making enormous efforts to reduce its share of that responsibility. For it has begun a vast program to modernize and depollute the pulp and paper industry, and another program, involving about six billion dollars, for the treatment of waste water. If we are to devote this sort of money to water purification, we must make sure that our efforts will not be brought to naught by the people upstream.

Nor can we remain indifferent to what is one of the themes of our deliberations: diversion of the waters of the Great Lakes. It is impossible to disassociate the quality of water from the water's quantity. For this reason, there is a Quebec government official on the Task Force on Water Diversions and Great Lakes Institutions, for any diversion project will inevitably have repercussions on Quebec. The idea of using water from the Great Lakes to deal with the water shortage which is expected to affect the neighbouring states, and possibly other states as well, can only give Quebec cause for major concern. Diversion of any major quantity of water would have serious and cumulative consequences on the St. Lawrence River itself.

Any reduction in the contribution of the Great Lakes to the average flow of the St. Lawrence will have a considerable impact both on economic activity in Quebec and on the standard of life of the Quebecers living along the river. A report of the International Great Lakes Diversions and Consumptive Uses Study Board describes how, by 2035, simply meeting the needs of water for the lakeside states would reduce the average flow of the St. Lawrence River by 10%. At present consumption levels, Quebec is already losing what has been estimated at several million dollars a year simply through the production of electricity—and this amount is increasing year by year.

A reduction in the average water level could also affect navigation, since the tonnage of ships plying the St. Lawrence would necessarily by reduced. At a time when ever-larger ships are using the St. Lawrence, any drop in the possibilities of navigability of that river and of the seaway could rapidly bring about economic catastrophe.

A reduction in the flow of the St. Lawrence could also make the regeneration of that river's waters more difficult. Algae would proliferate, the shores would deteriorate and, for millions of Quebecers, the quality of life would suffer. Irreparable damage would be done to the environment—to say nothing of the cost and inconvenience of the dredging which would be needed to restore the channel and the commercial and pleasure-boating ports.

Quebec's water purification program, which is now underway, would be seriously jeopardized, as would certain other major projects, like Archipel near Montreal. The St. Lawrence Task Force, attached to the ministere du Conseil executif, will soon be proposing a strategy for developing the St. Lawrence.

The Government of Quebec has already made known its opinions on these questions, particularly at Indianapolis, where Mr. J.Y. Morin was invited by the Great Lakes Governors in November 1983, and earlier in June of the same year, before the International Joint Commission. Firstly, Quebec would like to see the water of the Great Lakes preserved; any reduction in the flow of water resulting from the use of water would be compensated for by an equivalent amount of water from another source.

The balance of the Great Lakes basin must be protected. The Government of Quebec will collaborate to the fullest to achieve this. For we believe that our interdependence can be put to good use and that solutions can be found which will be of benefit to all concerned. And our governments can act together in a way which is both valid and functional.

Indeed, while several American states will soon be having to watch their traditional sources of water dry up, we are all too aware that farther north, Quebec and Ontario still have immense reserves of fresh water which are still usable. There can be no doubt that everyone would rather find a way to use the available resources to the advantage of all than witness the deterioration of the St. Lawrence/Great Lakes System to which we owe such a major share of our prosperity.

And the waters which divide the two countries will serve to unite us in the pursuit of our common interest.

In Canada, water constitutes a natural resource. As such, it falls under provincial jurisdiction. The Government of Quebec intends to assume its full responsibility in this area and to take an active part in any discussions which might arise from our joint search for rational management of water.

In Quebec, two departments share most of the responsibility in this sector. The Ministry of the Environment has already taken some highly innovative steps. The recent regulation laying down quality standards for drinking water is a "first", we believe, in Canada.

Still in the realm of water, this department has also gained considerable expert knowledge over a number of years through hydrological and sedimentological research. To this end, it has set up a major network of sampling stations across Quebec and a water quality monitoring system for determining concentrations of chemical products and toxic substances in the surface waters of the main watercourses in the St. Lawrence Valley. It is also keeping a much closer watch on the various works which might affect our water: bridges, highways, wharves, etc. And, at the same time, it is designing and doing the work necessary for protection against flooding and for regularizing water flow.

The Ministry of Energy and Resources—Hydro-Quebec falls under it—is responsible for maximizing the use of water for the production of hydro-electricity. The scope of Quebec's hydro-electric system provides a clear indication that successive Quebec governments have always assumed their responsibilities to the fullest in water management.

Quebec uses its hydraulic resources in many ways but, without a doubt, her production of hydro-electric energy has gained a reputation for Quebec which has spread far beyond her boundaries. The Government of Quebec is fully aware of the importance of this resource for Quebec's economic development. Early in the sixties, that government purchased most of the electricity producing and distributing companies within its territory. Hydro-Quebec became a major concern, capable of embarking on an integrated developement of our hydro-electric potential. Since that time, mighty works have been done: the Complexe Manicouagan-Outardes (5,500 megawatts) and, more recently, the development of James Bay (approximately 10,000 megawatts).

These mighty works, and their attendant needs for innovation in the realm of energy transmission, have required considerable research. Teams of researchers have been set up whose expert knowledge and skill are today recognized around the world. Through their work, Hydro-Quebec has become a leader in energy transmission. Hydro-Quebec is also closely involved with other partners in research on nuclear fusion, and much work is also being done in the area of hydrogen technology.

We are pleased to see that, today, the efforts being made by the people of Quebec can benefit the neighbouring states and provinces. Contracts for the sale of electricity have been signed or are being negotiated with several Canadian provinces and with some of the Northeastern New England States, and these contracts will make possible the use of clean energy at highly competetive prices. In today's context of energy insecurity, here is a contribution which cannot be neglected.

Already, Quebec is enjoying successful relations with a number of the New England States, particularly in the matter of acid rain. Agreements on water have been signed, or are being negotiated, with Ontario (Outaouais). I can assure you that Quebec will support the search for a rational use of the waters of the Great Lakes and the effort to maintain an ecological balance in this natural environment.

The water in the St. Lawrence and Great Lakes is our collective heritage. As it flows on, it must continue to bear the promise of health, happiness and prosperity for future generation. This summer, Quebec will be honouring the St. Lawrence on the occasion of the 450th anniversary of the arrival of Jacques Cartier in Nouvelle-France. Long may this great waterway prove a source of rejoicing—for our children and for generations to come.

I congratulate the Ontario Government for having organized this conference; thank you for inviting us.

## The Honourable Alan W. Pope, M.P.P.

*Minister of Natural Resources*

# Ontario's Water Resources

*Born in Scotland and a long-time resident of Timmins, Ontario, Mr. Pope was called to the Bar in 1972 after attending Waterloo Lutheran University and Osgoode Hall Law School. In the general election of June 1977, he was elected to the Ontario Legislature. Following two posts as Parliamentary Assistant, he became Minister without Portfolio in 1979. Since April 1981, he has held the Cabinet post as Minister of Natural Resources, where he has been active in supporting a "continuing combination of resources development, outdoor recreation and quality environment" in keeping with the social and economic well-being of the people of Ontario.*

When I was thinking about what I would say to you today, I found myself stepping back in time. After all, 1984 is Ontario's bicentennial. Two hundred years ago, the first United Empire Loyalists settled here.

Water brought them here. Water was the key ingredient in making this Province the strong economic centre it is today. And water will play an equally important role in the life and economy of this Province in the years to come.

Our earliest settlers would likely be puzzled if they could see us now, on the shore of this immense Great Lake worrying about water quantity.

After all, almost one-fifth of Ontario is water. Virtually our entire southern boundary runs through water, a 1,700 mile line through the St. Lawrence River and the Great Lakes to the Manitoba border.

Most people would probably be surprised to learn that Ontario has about 228,000 lakes, not to mention countless rivers and streams throughout southern and northern Ontario.

Since I'm from northern Ontario, from the City of Timmins, I'd like to point out that much of the Province's water wealth lies in our north.

As a matter of fact, about two-thirds of all the water that falls as rain and now in Ontario ends up in bodies of water that flow north to the Arctic watershed. The rest flows southward, eventually making its way into the Great Lakes and the St. Lawrence River.

Ontario is unique, it is the only province that borders on the largest chain of freshwater lakes in the world, the Great Lakes.

Many people who fly over the lakes marvel at the size of these vast bodies of water. And no wonder. Their total area is about three times the size of Nova Scotia, or about twice the size of the state of New York.

The volume of water in the Great Lakes is equally impressive. They contain almost one-fifth of all the fresh water on the earth's surface.

And the largest of the lakes, Lake Superior, is over 1,300 feet deep at its deepest spot. If you put the CN tower in the deepest part of the lake, the outdoor observation deck would be about 200 feet underwater.

No doubt, most Ontario residents would be surprised to learn that we do not have a limitless supply of water in the Great Lakes.

The Great Lakes are the product of the last Ice Age. They were carved out of the landscape by glaciers, and filled with water as the glaciers melted.

The only water we can use without threatening lake levels is the renewable supply. That's the water that falls as rain and snow and passes through the system regularly. This renewable supply is only about one per cent of the water in the Great Lakes. If we start removing more than this amount, we'll be dipping into a volume of water left by glaciation, and the lake levels will drop permanently.

Although we are constantly withdrawing a great deal of water on both sides of the border for a wide variety of uses, most of this water eventually returns to the system.

However, a portion of this water is not returned. This includes water that is assimilated by humans, plants and animals. It also includes the water that is incorporated into products during industrial processes or lost through evaporation while it is being used. All of these examples of water losses are what water experts refer to as water consumption.

Ontarians and Americans in the Great Lakes basin permanently remove, or consume, about 140,000 litres of water a second, or almost 5,000 cubic feet per second, from the Great Lakes. In just one day, the total water consumption in the Great Lakes basin is equal to about five times the amount of water needed each day in Metropolitan Toronto. This is the water that is lost to the system for water power generation and other uses.

Unless water use practices change, we'll eventually consume so much water that the lake levels will drop permanently.

The International Joint Commission predicts the amount of water consumed on both sides of the border could be up to seven times greater, or more than one million litres a second, by the year 2035 if current practices continue.

If water consumption gets that high, the levels of Lakes Erie, Huron and Michigan could drop as much as 13 inches. And the flow through the St. Lawrence River would be reduced by about 12 per cent.

Without question, this would be catastrophic for us, as you will learn more about today and tomorrow.

I would like to briefly outline now the importance of the Great Lakes to the Province of Ontario.

First of all, most of Ontario's residents live in communities along the Great Lakes. Almost 90 per cent of Ontario's population or about 7.5 million people, depend on waters in the Great Lakes basin. That's about one-third of the entire Canadian population.

And more than half of Ontario's residents, about 4.5 million people, get their drinking water directly from the Great Lakes. In fact, Great Lakes water is piped to communities as far inland as London and Newmarket.

Water is fundamental to our communities as well as our industries, our agriculture, our manufacturing, our tourism and our recreation. It is the key to economic wealth and jobs in Ontario, providing us with a quality of life second to none.

So every one of us in Ontario would be affected if the levels of the Great Lakes ever drop.

Without a doubt, the biggest economic loser in the province would be Ontario Hydro.

Currently, almost 20 billion kilowatt hours of power are generated in Ontario by waters flowing through the Great Lakes. That's about three times the electrical energy needed by the City of Toronto each year.

This amount of energy also represents about 60 per cent of Ontario's water power capacity, and about 12 per cent of all the electricity generated in Ontario.

The value of the water power generated on the Niagara River and on the St. Lawrence River at Cornwall is an astounding $650 million annually.

If more water is taken out of the lakes, there is less water flowing through the system, and that means less power is generated. I understand that every six-inch drop in lake levels would cost Ontario an estimated $20 million annually.

Besides providing a wealth of hydro-electric power, the Great Lakes are also a major transportation system. More than 100 million tonnes of iron ore, coal and grain were shipped through the Great Lakes/St. Lawrence Seaway Navigation System last year.

Just a one-inch drop in water levels in the shipping canals would reduce the amount of cargo shipped through the lakes by one million tonnes. This would cost the shipping industry millions of dollars in lost revenue.

But the huge tankers used by the commercial shipping industry wouldn't be the only vessels affected by lower lake levels.

Recreational boating could also be affected. That's because new docks or extensions to existing docks would have to be built to adjust to lower water levels. Marina operators would have to dredge their harbours. And some harbours and inlets might become too shallow for some boats.

As you can tell by looking out at all the sailboats and motor boats on Lake Ontario, Ontario residents are avid boaters. They own more than one milion boats. And about one billion dollars are spent in this province each year on boating activities. As well, about 22,000 people in Ontario are employed directly in recreational boating.

Ontario residents also flock to cottage country for their holidays and on weekends, as you'll be able to tell on Highway 400 on Friday night. Lower lake levels would be noticed in many popular cottage areas, particularly along Lake Huron and Georgian Bay.

This could spell trouble for many of the valuable wetland areas along our 3,200-mile Great Lakes shoreline, areas that are so important as wildlife habitat and fish spawning grounds.

As for fishing, sports fishermen alone put over $200 million into the Ontario economy every year. And commercial fishing on the lakes is a $30 million industry in Ontario, employing about 2,000 people.

The list goes on and on. Clearly, we cannot afford the economic and environmental destruction that would result from lower lake levels. So we must find ways to curb our growing demand for water in the Great Lakes basin.

But water use in the Great Lakes basin isn't the only water quantity issue that demands attention. We in Ontario are equally concerned about the growing pressures in the southwestern and midwestern United States to divert Great lakes water to meet increasing water needs there.

Although we recognize that these regions are increasingly being faced with serious water shortages, we simply cannot support any further diversions out of the Great Lakes basin. We in Ontario need, and will continue to need, every drop of water we have.

Of course, diversions are not unheard of in this province. Dams in northwestern Ontario divert north-flowing waters into Manitoba to meet water needs in Winnipeg.

And two bodies of water in northern Ontario that used to flow towards James Bay, the Ogoki River and Long Lac, were turned southwards in the 1940s for a series of water power stations and for log driving. These waters now empty into Lake Superior. These diversions are worth an estimated $53 million annually to the Great Lakes region.

However, Ontario does not get the full economic benefit from these diversions into Lake Superior. That's because, while we're putting water into the Great Lakes at Lake Superior, water is being permanently removed from Lake Michigan through the Chicago Sanitary and Ship Canal.

Therefore, those waters which should be flowing down the system for power generation and creating draught in ports for commercial shipping are sent elsewhere. This is, of course, to the detriment of Ontario but for the benefit of our friends south of the border.

The Chicago Canal was first built in 1848 to create a canal barge system from Lake Michigan to the Mississippi River and to flush pollution out of Chicago. Each second, about 90,000 litres of water, or about 3,200 cubic feet, are permanently removed from Lake Michigan by this diversion. This water never returns to the Great Lakes.

Unfortunately, Canada has no jurisdiction over Lake Michigan because, unlike the other Great Lakes, it is totally within the United States. The rate of flow is limited by the U.S. Supreme Court. Also Washington could unilaterally decide to increase diversions from this lake.

However, we in Ontario are protected against diversions from the other four lakes by the 1909 Boundary Waters Treaty. This treaty gives both countries equal rights to use all boundary waters. it says that the International Joint Commission has to approve any diversions out of boundary waters.

We are also protected against diversions out of the Great Lakes basin by our neighbours in the Great Lakes states, who are equally opposed to the concept.

As many of you know, the Governments of Ontario, Quebec and the Great Lakes states agreed to a resolution at Mackinac Island two years ago this month on Great Lakes water diversions.

It stated that all of us object to any new diversions of Great Lakes water for use outside the Great Lakes states and provinces. It also said that the governments of Ontario, Quebec, the Great Lakes states and the Canadian and American Federal Governments should agree to any future decision on the diversion of Great Lakes water.

This kind of strong regional co-operation is also reflected in a number of other recent initiatives.

For example, an Ontario representative sits on a recently-formed Council of Great Lakes Governors Task Force on Water Diversions and Great Lakes Institutions.

Also I am most gratified that many of our Great Lakes neighbours have included references to Ontario when proposing various anti-diversion bills in state legislatures and in Congress.

We must work to continue this spirit of co-operation and ongoing dialogue if we are to conserve and protect the Great Lakes for future generations.

The first step must be to learn more about our water use practices in the Great Lakes region and find ways to conserve water wherever possible.

This is particularly important in the American Great Lakes basin, where most of the consumption occurs. However, I would like to point out that, even though the Great Lakes states consume seven times more water than we do, they have only three-and-a-half times our population.

We've asked Ottawa to request that the International Joint Commission study water losses and water conservation further. The Great Lakes states have asked Washington to do likewise.

We're keeping the lines of communication between Ontario and the states wide open. We're meeting regularly at conferences like "Futures in Water" to talk about our mutual concerns and possible solutions.

Together, we're trying to learn as much as we can about the way we use water. We're also banding together as a region to ensure that our concerns about possible future diversions are heard.

Besides working as closely as possible with our Great Lakes neighbours, my Ministry is currently strengthening its own role as the manager of this province's water resources.

For years, my Ministry has been responsible for regulating water levels in much of this province for flood prevention, hydro-electric power, boating, swimming and fishing.

Ontario was a pioneer in the promotion of watershed management through our Conservation Authorities. When you look at some of the recent flooding problems that occurred in the states, you can appreciate the fine job that our Conservation Authorities have done over the past 35 years. The basis for this success is in part due to our unique partnership with municipalities.

In addition to these efforts, my Ministry also recently introduced a new wetlands policy which is designed to give special protection to these important areas in Ontario.

With water becoming an increasingly valuable resource in North America, my Ministry's water management responsibilities are expanding.

In addition to our traditional water management responsibilities, we're starting to look more closely than ever before at our water supply, our water uses and future demands for our water.

We have to ensure that we are prepared to face whatever the future brings.

I think one of our most immediate tasks is telling the people of Ontario that our supply of water could be reduced in the years to come and convince them that we cannot allow this to occur.

That's why we're holding this conference, to make the residents of Ontario aware of these emerging issues.

That's why today I am releasing the first-ever water atlas on Ontario. It is called "*Water Quantity Resources of Ontario*". Each of you received a copy when you registered. This timely, informative document is designed to increase our understanding of the importance of our water resources.

Yet the conference and the atlas are only the beginning. My Ministry plans to improve and enhance the basin-wide management of our water resources, particularly those in the north.

I intend to meet frequently with various technical groups such as the Canadian Water Resources Association as well as other interest groups and the Federal Government to discuss the future management of our water resources.

By working closely with others, we will build on the dialogue begun at "Futures in Water". We will enhance the public's awareness and understanding of these issues. I intend to ensure that everyone's views are heard as we make the decisions that will decide the future of our water resources.

Of course, as I mentioned earlier, we alone cannot decide the future of the Great Lakes, since they are an international resource.

Obviously, any attempt to conserve and protect the lakes must be basin-wide.

I have thought about various basin-wide approaches to our water quantity concerns and I would now like to suggest some of these ideas.

I hope that these suggestions and others will be discussed and considered at "Futures in Water" and in the months to come.

As for growing water use in the Great Lakes region, I think we have to take a closer look at the water practices at power plants in the United States and by industries in both countries.

Within 50 years, thermal power energy and manufacturing are expected to account for almost 90 per cent of all water consumption, well above their 60 per cent share today. The water is used as a cooling medium to remove the heat produced by the thermal generating process.

I understand that much of this loss is due to evaporation through thermal power cooling towers used in closed-cycle cooling systems in the states. Huge volumes of water are evaporated through these open cooling towers.

Here in Ontario, our power cooling systems are called once-through condenser cooling systems, which means they are totally enclosed so there are no evaporative losses.

We should also examine more efficient water use practices for industries.

Perhaps we could encourage wise water use if we put a price tag on water consumed by power plants and industries. Currently, they take water directly from the Great Lakes and pay nothing.

While we're at it, why not examine municipal water pricing policies as well?

What about providing incentives to industries and the academic community to find ways to reduce water consumption?

Why not set up a U.S./Canada Water Quantity Agreement and a Water Quantity Board similar to the effective U.S./Canada Water Quality Agreement and Board?

However, I don't want to advocate the proliferation of water quantity groups. As you know, there are already numerous committees, groups, association, councils and boards on both sides of the border dealing with water quantity.

Perhaps we should consider consolidating some of these and more clearly defining their responsibilities and mandates.

As for the threat of diversions to outside the Great Lakes basin, perhaps we should consider revising the 1909 Boundary Waters Treaty to include Lake Michigan and the Chicago Diversion.

I would also like to encourage our American neighbours in the water-short regions of the United States to continue their efforts in water conservation. I applaud the progress that has been made in many arid regions of the United States in recent years.

Yet, in speaking as an outside observer, I would encourage you to take an even closer look at your own conservation practices before looking north.

I raise these ideas to stimulate a productive dialogue at "Futures in Water", a dialogue I am confident will continue and will grow to include more people in the months to come.

And I am looking forward to hearing what the rest of you have to say about these water quantity concerns.

Clearly, we in Ontario face significant decisions on the future of our water resources in the years to come.

I believe that "Futures in Water" is an important initial step in leading us to more informed and more active water planning in the future.

I thank all of you for caring enough to be here today, and look forward to continuing our water dialogue in the future.

## Session I—Questions and Answers *(Edited)*

*Premier Davis*

Thank you very much, Alan. In listening to the four individuals who spoke to us at the beginning of this Conference, I trace a little bit of history. I perhaps didn't clearly identify the role played by former Governor Milliken. I think one of the encouraging things I found in public life is that, while we have two distinct systems of government and while we have certain differences on issues on some occasions, the discussions over the years on quality, environmental issues and now the focus on quantity in the Great Lakes system, have brought together, like no other issues, the states bordering on the Great Lakes, the province of Ontario and our sister province of Quebec. I can't think of many other countries in the world where that sort of relationship, in a very civilized, constructive and positive way, could have developed as it has between the United States and Canada, and amongst the provinces and the states of the Union. In fact, I guess that the first time in my political history that I was asked to sign a resolution from the Great Lakes Governors, here I was a Premier from the province of Ontario, that small jurisdiction to the north of these mammoth states, and here I was, executing a document. I reminded all of them that it had no legal status, and that no one could sue us or be sued on the basis of that document, Alan, but it was a step and a very encouraging one when I was asked to participate, along with my colleague from Quebec, in the signing of that initial memorandum or that agreement. I guess that really led to the Conference today, the focus on the Great Lakes basin, the fundamental importance in this area of North America to both the United States and to Canada. It also began to focus on issues other than just quality, which had been our preoccupation, and properly so, for a number of years, onto the question of quantity. I think, as I listened to Governor Milliken this morning express his point of view, he was reflecting his concerns, I think as a former Governor, and now President of a very unique and helpful organization that has been established related to the Great Lakes, and as I listened to him, I sort of reflected on his days as Governor when he felt very keenly that this was an economic resource available to the people of Michigan and that it should be utilized as a resource, and not necessarily that it should be ruled out of competition and economic development that is taking place in some other parts of the United States. We don't have that situation here. Quebec is always ahead of us in terms of economic development, Mr. Morrissette, so we never have these debates, but I think he gave us a perspective of Great Lakes Governors' points of view which I think they continue to show. I was really encouraged by the thoughtful presentation from the Governor of Utah because, while we hear of these potential diversions and we hear of the pressures growing within some parts of the United States to gain access to the Great Lakes basin, it was obvious from Governor Matheson's observations that he felt that the problem should be dealt with, if at all possible, within the individual jurisdictions and that certain programs within those jurisdictions could resolve a part of the problem. I also heard him say, as I mentioned earlier, about what was happening in the state of Arizona and I wonder, in terms of the political pressures, just now much of that can be accepted without looking to outside jurisdictions to help solve the problem. I just wanted to communicate that point of view or that thought to the media because sometimes we get excited by reports or rumours or proposals that we hear about, and part of the reason for the Conference is to understand just what substance there may be and what concerns we should develop. I guess that, while the possibility of diversion is that which attracts the imagination of people, something that is within our capacity in the Great Lakes basin is the question of consumption. It doesn't provoke the same attention from the media, perhaps, because it's not a question of conflict or controversy. It's a question that we are consuming more water from the Great Lakes basin that was the case a generation ago. There appears to be no sign of this altering and the I.J.C. which, in my view, has begun to be not only understood and accepted, but is playing an increasingly important role, has made it abundantly clear to all of us, if consumption rates continue at the rate that is presently set for us, that without even questioning diversions, there will be problems created within the Great Lakes basin. Part of that has to be resolved by the individual jurisdictions but, as Alan has pointed out, consumption cannot be dealt with totally by individual jurisdictions. It will require something of a co-operative approach in terms of the studies, the assessments, and the policies that I think need to be developed to see that consumption is under some significant measure of management. I shouldn't express those personal points of view becuase I'm only the Chairman, but as I listened to the participants this morning, I couldn't help but reflect these to you. The program indicates that there will now be an opportunity for those of you who may have questions of those who made contributions this morning, or observations. Who would like to either ask a question or state some concerns?

*Question*
My name is Lorne Creighton, Mr. Chairman. The term 'ecosystem' has arisen in a number of the presentations that have been made this morning, and I was puzzled by a lack of reference to other variables that affect water quantity in the Great Lakes basin when we look at it from the point of view of an ecosystem, and I'd like to raise just one. Dr. Richard Thomas, who in assisting to present the report of the Science Advisory Board at the I.J.C. meeting in Indianapolis last November, quoted a report in Science Journal from the U.S. that, if current rates of increase in deposition of $CO_2$ into the atmostphere were to continue, that within the time frame we've been discussing for most things this morning, up to about 2035, there would be an increase in the mean temperature in the basin, a drastic reduction in precipitation in the basin, and a consequent drastic reduction in flow in the Great Lakes. In the directions that are being taken, perhaps this question could be addressed to Mr. Pope. Is there an intent to look at the question from the point of view of an ecosystem in which things like this will influence the flow, perhaps as much as or more than consumptive uses?

*Premier Davis:*
I think, sir, that I will ask Mr. Pope to answer that question. I could give a brief answer, yes, but I think Mr. Pope would like to comment on that in greater detail.

*Alan W. Pope:*
Mr. Premier, I think that during the course of this Conference, some of the points related to environmental or atmospheric impacts on water quantity or water cycles is certainly relevant to be considered and developed as part of the discussion and perhaps recommendation out of the Conference. I think the International Joint Commission, in its studies, is looking at all possible sources of water loss including atmospheric conditions that may lead to a reduction in precipitation. Definitely, that is not being ruled out as part of an overall water quantity and water quality process. No emissions of carbon dioxide, carbon monoxide or sulphur dioxide are ruled out in terms of being considered as having an impact on both water quality and water quantity. This is one of the issues that we have collectively been trying to face in the Great Lakes watershed basin and one that we will continue to work on common policies with our sister state governments in the Great Lakes Basin. I was recently at a Great Lakes Governors' Conference and a mid-west Governors' Conference and I sensed some recognition of those issues in the discussions that took place and some willingness to come to a detailed and technical consensus of what has to be done on a regional basis to address the issue.

*Question:*
You brought up the possible problem that would occur with the displacement of user groups, i.e., Central Arizona—how much will people put up with that displacement? I would just like to point out that, according to the census bureau of the United States, currently the Great Lakes states have more representatives in Congress, 145, than the entire western half of the country, that's North Dakota, Texas westward. They have 125. According to a Congressional Research study based on the census projection, representation in the west will increase to 174 by the turn of the century, while that of the Lakes states declines to 125. I'd just like to suggest that the increasing power in the west would decrease the likelihood of various groups being displaced there and perhaps increase the pressure for diversion from other outside sources.

*Premier Davis:*
You were saying, sir, as a political scientist, which is a discipline learned by Governor Matheson and by the Premier of this Province, that your politically scientific logic leads you to the conclusion as population shifts occur in our great neighbour to the south and under our democratic and representative systems of government, there will be larger numbers of representatives in the U.S. Congress emerging over a period of years from the southwest and the west that might alter the balance and the commitment of Congress in terms of diversion. Sir, you didn't identify yourself, but quite obviously you are a resident of the United States. I would never make those observations about what might happen here in Canada.

I sense what you are saying to the group here is that, with the shift in population goes the representation in the Congress and gives a little different balance to Congress, so the pressures for possible future diversions, in your view, may increase just because of that shift. As a non-scientist, I think you're quite right.

*Question:*
My name is William Griffin. I'm here as a concerned resident of Michigan and I have a question for Mr. Pope in relation to the last gentleman's comments. I'd like to explain that, in historical reference, we are having a diversionary déjà-vu. In 1894 and '95, Mexico claimed legal damages for injury to its farmers by diversions of the Rio Grande in the United States. The Secretary of State asked Attorney General Harman, a water resources politician from Wyoming, to write the United States' reply. Harman replied, in effect, it's our water. We do with it as we please. In the mid 1950s, the proposed diversion of the Columbia River in Canada was protested by the United States. There was poetic justification, and I've always admired the Canadian response, namely, it's our water and we can legally do with it as we please. A lesson of history that we have been hearing again this morning is that whenever and wherever there is a

felt need, there has been and there will be diversion. No rhetoric or writ can cancel a drop of it, but the Harman doctrine is dead. It's our water, they shan't have it diverts us from getting on with the business of the long range and broad-based planning. The unit of planning must be the ground water and the flowing water of the watershed basin and the continent beyond. The hydrological cycle circles the globe. No drop of water and no basin is an island unto itself. Every basin is a piece of the continent and a part of the main; any diversion diminishes somebody and enriches somebody. So, we are all gainers and all losers. In the cases of diversion of international water basins around the world, lawyers, arbitrators and judges have induced the principle of equitable utilization. Equitable utilization is a political process. It does not protect potential future uses of water. The best way to protect our water is co-operative, long-range, broad-based, basin-wide planning now for its 100% use within the basin in ways we want it used. Without that, we are helpless to prevent future diversions. What is wanted now, it seems to me, is a planning entity of the Great Lakes provinces and states. Surely we can find a way to do this within the aegis of the external affairs powers of our two federal governments, and it seems to me that the people of the Great Lakes basin should join together in a formal intergovernmental, state government and provincial governments, planning compact entity even though, as Mr. Pope said, maybe we don't need another layer. But it seems to me that we are our own best protection against both Ottawa and Washington, and I'd like to hear Mr. Pope's comments on what is the assessment of the desirability and the feasibility of such a planning compact.

*The Honourable Alan W. Pope*
Mr. Premier, I think there has been a recognition by Premier Davis, some years ago, that water quantity issues required some attention on a United States-Canadian basis. I think our goal has been to achieve, in a very detailed way, an informed regional consensus on all water quantity issues, demands for the future, and how we are going to meet them and still maintain the Great Lakes levels that we need to sustain our communities, but, secondly, to deal with the issue of diversion and what we are trying to do, it started with Governor Milliken's conference in Mackinac Island. What we are trying to do is evolve from the discussions between Premiers and State Governors to discussions with technical experts and people knowledgeable on water quantity issues, to evolve an informed regional consensus from the Great Lakes basin including both American states and Canadian provinces so that it doesn't become a conflict between Americans and Canadians and, if we have an informed regional consensus and we know where we're going as a basin, both Americans and Canadians can take our positions to our respective federal governments with a greater degree of strength and a greater hope of success.

The idea of an entity, made general reference to in my comments, certainly is probably an organizational goal that we have, but I think, before we get there, we have to have a fuller discussion like we're having in the next two days.

*Premier Davis:*
I would just add, as a matter of policy, that what Alan has said would be acceptable to the Government of Ontario, and would be relatively unique. I would not presume, obviously, to speak for the Government of Quebec, but I would sense, Mr. Morrissette, that an entity involving the Great Lakes states and the two provinces of a more formal nature would be, in policy terms, acceptable. How you would structure it and what effect it would have, obviously it would not have any legal effect, in fact it wouldn't have any status within the constitution of your country or ours. But, in terms of providing a focus in terms of communicating with our two national governments, an entity such as you suggest, I think, as a policy matter, is attainable. I think we have some homework to do, some educational process to go through. But, as Alan pointed out to you, when I've been involved with the Great Lakes Governors discussions, that has been in the back of everybody's mind and yet I'm not totally sure as to how we get there and how soon. I think we've made some progress. I can only think very personally that Ontario would participate in such an entity. But, as Alan explained, I want it to evolve and emerge and be based on a consensus. I would be very reluctant to develop a system whereby any sort of controversy was developed between the Great Lakes States and our Province, and I'm sure this would be true of Quebec as well. But, sir, I think you really have captured a part of the rationale of this Conference and I appreciate your observations.

*Question:*
Thank you, Mr. Premier. My name is Henry Regier. I'm a University of Toronto professor. The previous speaker, Mr. Griffin's comments, brought to mind a suggestion that Mr. Charles Ross has made a number of times in recent years, and that is that there be convened in the basin a kind of Great Lakes version of the Stockholm Conference which was held in 1972 and brought to the world recognition of various problems of the environment, international problems of the environment. Now, I can't speak for the details of Mr. Ross' plan, but if it were like the 1972 Stockholm Conference, it would be preceeded by a preparatory committee involving government people, but also non-government people to review various issues related to the Great Lakes for use as position papers and a draft action plan. Then there might be a meeting convened by the governments, perhaps by the two governments on both sides, to review the action plan, and concurrently, there might be a non-government session to deal with aspects informally and, out of that would come a draft action plan

that would be agreed to by the two nations and not be binding. I'm just passing along some suggestions of Mr. Charles Ross, a former Commissioner of the International Joint Commission, that I think would be consistent with Mr. Griffin's points.

*Premier Davis:*
Our colleague from Quebec would just like to make an observation on that.

*Mr. Morrissette:*
If I just may add that our Minister of Intergovernmental Affairs, when we hosted the State Dinner last October, the Great Lakes Commission was very open and very keen on such an idea, and I think I can speak on behalf of our government that we would be recipient for such a compact or whatever the name is, and a second point I'd like to make is that, with Ontario and with the eight Great Lakes states, Quebec is already working on the more economic development-oriented issues under the umbrella organization that was created in Quebec City last October with Ontario and the eight Great Lakes states called the St. Lawrence Great Lakes Maritime Forum which is aimed at other issues than strictly quantity or quality of waters. It's a little bit more commercial-oriented and economical development-oriented, so there is already a little precedent there that is quite similar to the concept that was passed out a few minutes ago. Thank you.

*Premier Davis:*
Thank you very much, Mr. Morrissette:
Mr. Pope had an observation to make in reply to our friend from the University of Toronto.

*Alan W. Pope:*
I would just like to add that the governments of Quebec, Ontario and the federal governments have been monitoring the activities of the National Water Alliance in the United States, it's co-chaired by Senator Durenberger of Minnesota and Senator DiConcini of Arizona. They've had a number of regional conferences that had been attended by myself or other Ontario representatives and we have started discussions with them. The Federal Government has also initiated a study group who are here at this Conference who will be involved in some of the Conference to finalize a Federal Government position on this issue in concert with Ontario and Quebec. I think we're heading towards the kind of conference that you indicate, but I think there is some preliminary work that has to be done including discussions on a basin-wide basis as we are doing here at this Conference.

*Question:*
My name is Anand, Premier Davis. I would like to say to your panel members that some of the thinking which I have listened to carefully needs revision because water has two elements, in it, one is water quantity. You know a pail of water is a pail of water. But the flowing water has an element of time in it. If you build a dam in 1980 or 1990, billions of dollars worth of water is either used or not used either for power or for recreation or for tourism. I would be pleased to assist your advisors in making this distinction when you take those cost-benefit ratios. I have already written a number of papers which have been commended for international awards. If you take the element of time, you're thinking on major matters will change because water is not like uranium or coal or any other commodity. It has this unique aspect to it. Thank you.

*Premier Davis:*
Thank you very much, sir. Mr. Pope reminds me that yours is the last observation or question.

# J.P. Bruce

*Assistant Deputy Minister, Environment Canada*

# Luncheon Address
# The Climate Connection

*Following an M.A. in physics/meteorology in 1952 at the University of Toronto, Mr. Bruce joined the Meteorological Branch of the Department of Transport. For the next twenty years, he was active in hydrometeorology, published a University-level textbook on the subject and, in 1970, became the first Director of the Canada Centre for Inland Waters in Burlington, Ontario.*

*From 1972 to 1976, he served as Canadian Chairman of two International Joint Commission Boards dealing with Great Lakes water quality and research. In 1977, he was appointed Assistant Deputy Minister, Environmental Management Service (lands, forests, water and wildlife).*

It is 15 years ago since man first walked on the moon. The most important and remarkable result of this unparalleled engineering achievement of the United States was not, as some people claim, the technological developments and spin-offs. No, it was rather the revolutionary new perspective of our planet Earth that became possible and that filled the astronauts with wonder. And, as we on earth saw those beautiful photographs of earth rise over the dead moon, much of mankind looked upon our earthly home with new eyes.

The astonishing thing is that Earth is alive in a corner of the cosmos where all other bodies are lifeless. The photographs demonstrate life in the green of much of the continents, but they also show why our planet is alive. Much of the image is blue with water, or wreathed in the white of the clouds of our atmosphere. This, then, is what makes our planet unique, the water and the air. These two essential elements are very closely interlinked. The climate, or long-term state of the atmosphere, is mainly responsible for the distribution of fresh waters. That climate, in turn, is profoundly influenced by the oceanic waters on the globe.

Man is the first species on earth to have the capability of modifying, in a major way, the way the waters flow, and even to modify the atmosphere. This means that we have assumed a great responsiblity. We should, if we are to alter the balances, be sure we can predict and understand the consequences, and be convinced that these are reasonably tolerable. In the past and to the present day, man's track record in this connection is not encouraging. We have diverted rivers, built dams, and used our lakes in ways that may have had some immediate benefits but have also had adverse long-term side effects. These effects have been usually local or regional in scale.

Carbon dioxide and a few other gases in the atmosphere have a large role in controlling the thermal balance at the earth's surface. They allow the penetration of the sun's energy to heat the earth's surface, but they limit the amount of energy the earth sends back to space. Since the beginning of the industrial age, man has been burning fossil fuels and discharging increasing amounts of carbon dioxide into the atmosphere. Since pre-industrial times of the 1800s, the $CO_2$ concentrations all around the globe have increased from less than 280 to 340pp mill/ v. In measurements from Mauna Loa in the Pacific to Sable Island in the Atlantic, and from the South Pole to Alert in the Canadian Arctic, recent increases in $CO_2$ concentrations have been at a steady rate of 3-4% per decade.

While this $CO_2$ quickly becomes evenly distributed in our well-mixed global atmosphere, we know that 95% of the anthropogenic $CO_2$ emissions come from the industrialized countries of the northern hemisphere. At the same time, other gases with effects similar to $CO_2$ concentrations have been at a steady rate of 3-4% per decade.

While this $CO_2$ quickly becomes evenly distributed in our well-mixed global atmosphere, we know that 95% of the anthropogenic $CO_2$ emissions come from the industrialized countries of the northern hemisphere. At the same time, other gases with effects similar to $CO_2$, like chlorofluorocarbons (CFCs), continue to increase in the world's atmostphere. CFCs were once used in spray cans in North America, and still are elsewhere, and continue to be used in refrigeration everywehere. The combined effects of these greenhouse gases, should they continue to increase, will profoundly affect climate and, in turn, the distribution of fresh water in the world.

In addition to the greenhouse warming effect that $CO_2$, CFCs and other gases will cause, scientists try to take into account the cooling that can be induced by particulate matter injected into the atmosphere by volcanic eruptions and, far less spectacularly, by many of man's activities. The drastic increase in particulates from eruptions of Mount St. Helens, El Chichon in Mexico and from volcanoes in the past, is known to reduce incoming solar radiation significantly, but usually only for periods up to a year or so.

In contrast, the change in $CO_2$ and other gas concentrations is a continuing steady, and seemingly inexorable, effect. This appears to be the dominant factor at work to change the climate as long as man continues to burn fossil fuels: oil, gas and coal. Estimates of future $CO_2$ concentrations and those of other gases are based on rates of increase of these gases over the past few decades, and on projections of energy and economic developments in the world. They suggest that $CO_2$ concentrations will be almost double pre-industrial levels by some time around the middle of the next century, 60 to 80 years from now. Based on this projection, scientists have used mathematical models of the general circulation of the atmosphere to make estimates of future climate conditions. A number of such models have been developed, all involving some simplifying assumptions about the atmosphere and the underlying oceans. This means that, while they give consistent and useful indications of future climates, they are still far from infallible. Among the best are the models of Manabe and his colleagues at the Geophysical Fluid Dynamics Lab at Princeton.

A doubling of $CO_2$ would, by Manabe's model, result in winter temperatures averaging 3 to 4°C (5 to 7°F) higher over the Great Lakes basin, 2 1/2 to 3°C (4 1/2 to 5°F) higher over the northern Great Plains, and more than 6°C (11°F) in the high Arctic winter. Summer temperature increases would be somewhat less, 2 to 3°C over the Great Lakes region and thenorthern Great Plains, and slighly less in the Arctic summer. To those not familiar with data on the very stable long-term climatic conditions, these may seem to be small changes—but they are not. They are large increases when measured against the climatic fluctuations of 1 to 2°C in the last 8,000 to 10,000 years of the earth's history.

Precipitation changes are much more difficult to predict by such models, but the suggestion is strong that small increases in precipitation will likely occur in the Great Lakes basin and in the Great Plains region. These will probably be much too small to compensate for increased evapotranspiration from crops and much greater evaporation from large lakes like the Great Lakes.

Given this kind of scenario, what are the most likely consequences for water resources and agriculture? On the agricultural front, areas like northern Ontario and the northern Canadian Prairies will see increases in growing degrees above 5°C of 25-30%, making northern areas with suitable soils capable of growing crops now characteristic of regions several hundred miles further south. Southern Ontario, northern Michigan and New York State will be similar in climate to the present U.S. corn belt, and will require increasing irrigation waters. There will be increasingly dry conditions towards late summer, but not serious droughts. However, in the more southerly Great Plains of U.S.A. and the southern Prairies of Canada, droughts will be much more frequent and severe.

In the Great Lakes basin, the main effects will most likely be increased evaporation losses from the lakes themselves, and decreased runoff from the land drainage parts of the basin. These two factors have been estimated in several recent papers by staff of Environment Canada and the U.S. National Oceanographic and Atmospheric Administration. The results indicate a probable decrease in outflow of 21% of present average values. This is based on a climate scenario involving a 3°C average increase in the monthly mean temperatures in the basin, and a small increase, up to 6 1/2%, in precipitation in the basins of the lakes. A decreased flow of this magnitude, 21%, would have significant effects on water depths for shipping, on the shoreline of the lakes and, perhaps most seriously, a loss of hydro power production at Niagara and in Ontario, New York and Quebec on the St. Lawrence, worth $3/4 billion per year, in 1984 dollars. Water quality could also be adversely affected, with higher concentrations of contaminants in lower level and flow conditions.

But will the climatic effects be the only long-term factor affecting Great Lakes levels and flows in the next 50 to 65 years? The answer is clearly no. Consumptive uses of waters of the Great Lakes system are projected to increase markedly between now and 2035.

The most definitive study of diversions of water in and out of the system, and of consumptive uses in the basin, was published by a Board of the International Joint Commission (I.J.C.) in September 1981, in response to the governments' Reference of February 1977 to the Commission.

There are two basic results from that study. One is that consumptive uses of water in the Great Lakes basin will be, in the next 50 years, far more significant than *present* diversions, into and out of the Great Lakes, in affecting lake levels and flows in the St. Lawrence and connecting rivers. Consumption will increase at a rate between 1.9% and 3.2% per year, with the most likely rate of growth being 2.7% per year in the U.S.A. and 3.3% in Canada. This growth will be due, in significant measure, to nuclear and conventional thermal power production, and corresponds to an outflow of 25,400 cfs. This is 20,500 cfs more than consumptive uses in 1975. Increased loss to the system is equivalent to 8.6% in the mean flow of the St. Lawrence River. The most likely reduction represents a $300 million/year loss in hydro-electric energy production in addition to the 3/4 billion loss due to climatic change. It should be noted that consumptive uses of the waters are only a small fraction of the total withdrawals of 300,000 cfs in excess of the total average outflow through the St. Lawrence. More than 90% of the withdrawals are recycled back into the system after use.

The second main result is that, in the most likely projection, the consumption of water by the U.S. will be 20,900 cfs, and by Canada, 4,500 cfs. That is, by 2035, 50 years from now, consumptive water losses due to economic activities in the United States will continue to be more than 80% of the total.

In its study, the I.J.C. Board assumed that climate and water supplies to the lakes would be the same as it has been in the past 60-100 years. As has been noted, this now appears to be a shaky assumption. Much warmer conditions will most probably occur, increasing evaporation from the lakes and evapotranspiration from the land and crops.

One way in which this would modify the I.J.C. study results is to increase the projections of irrigation water needs. The I.J.C. Board assumed relatively slow growth rates for irrigation and stock-watering consumptive uses, with most likely projections being 0.9% to 1.9%/year respectively. There will be much greater crop-growing potential, due to higher temperatures, but little increase in precipitation. This means that there will be tremendous economic opportunities for the region if greatly increased irrigation water demands can be met.

Another effect of a warmer climate will be a reduction in winter energy demands, but this is likely to be offset by increased demands for electricity for summer air conditioning. So, with much increased irrigation uses in the states bordering the Great Lakes and in Ontario being the probable change, the total projected consumptive use given by the I.J.C. study is likely on the low side.

But it is not just the climate change in the Great Lakes basin that may affect water use in this region. As noted earlier, droughts on the Great Plains are projected to be far more severe and prolonged, beginning with the next few decades and increasing as the "greenhouse" effect grows. This will result in increasing pressure for large diversions from the then-dwindling water supplies in the Great Lakes system and from the northward flowing river systems of the continent.

Large scale diversions of the northward flowing rivers would also have climatic effects of significance. Decreased fresh water inflows to Hudson Bay and the Arctic Ocean would result in increases in the salinity of Arctic waters. This lowers the temperature at which ice forms and would add to the already enormous Arctic warming predicted due to the "greenhouse" effect. So the conditions of increased warmth and drought in mid-continent could be further exacerbated. But, you might say, only one diversion from say, Hudson Bay and James Bay would surely not have much continental or global effect. Unfortunately, North Americans are not the only ones contemplating such diversions. In the USSR, very major reductions in fresh water flow to the Arctic would result from some schemes now on the drawing board. It appears likely that the USSR will go ahead with some diversions from the Arctic, such as the one into the Volga River, to try to raise the level of the Caspian Sea, which has already fallen 3 metres or 9 1/2 feet due to many factors, including drier and warmer climatic conditions of the past 55 years.

So far, this discussion has said nothing of the environmental consequences of such diversions. Diversions are often characterized as making use of "wasted waters". From the perspective of the ecosystems of the northern regions, none of the water flowing to the northern seas is wasted. Every drop is used to sustain life forms in these northern systems. In addition, the fresh water flows affect the carefully balanced energy exchanges in this region which are of great importance in shaping the climate of the whole hemisphere.

It is for all of these reasons: the uncertainties concerning future Canadian water demands and supplies, the economic flexibility that an adequate water supply can bring, and the potential environmental disruptions that Canada has long had a policy position opposed to the export of water.

Let me now summarize our dilemma in the Great Lakes region and assess how this should affect our policies.

- We are changing the chemical composition of the atmosphere over the globe, and this probably means an increased greenhouse warming effect over the Great Lakes basin and the world.
- Due to the most probable climate change and increasing consumptive uses of water in the Great Lakes basin, water supplies could be reduced significantly beginning in the next decade or two and reaching a magnitude of approximately 30% about 65 years from now. The cost of replacing the lost hydro-power production would be about $1 billion (1984 dollars) annually.
- More than 80% of the consumptive uses in the basin will be in the U.S.A.

- Due to the probable warming trend, much more productive and higher-valued agriculture crops will be possible in the Great Lakes states and Ontario, provided enough irrigation water can be allocated.
- Attempts to restore lake levels by major diversions of northward-flowing rivers may well have the effect of further increasing the climatic warming and could have profound effects on polar ecosystems.

The major policy implications seem clear enough.

1) We should begin planning for lower water levels and decreased hydro-power production in the Great Lakes system.
2) As consumptive uses increase, there will be a need to recognize the disproportionate amount of water consumed by each country.
3) States and provinces bordering the Great Lakes should plan to seize opportunities for increasing agricultural productivity by ensuring that potential irrigation water supplies are retained for use in the basin.
4) For reasons of climate, economic opportunities and environmental values, we should be extremely cautious about considering any further diversions of water into or out of the Great Lakes system.

Let us return to our new view from the moon of the beautiful blue, white and green Earth, sustained by waters and the air. We know we are significantly changing the chemical composition of the atmosphere, and there appears to be little we can bring ourselves to do about it, since we are all hooked on the burning of coal, gasoline and natural gas, until a nuclear age really dawns. The climatic consequences of this are only beginning to be understood and appreciated. Let us not now compound the problem by further major manipulation of the water systems of the continent, unless and until we understand much more completely the consequences of our actions.

## James W. MacLaren,
*Consulting Engineer*

# Interbasin Water Management

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Welcome to this afternoon's session in the "Futures of Water" that will be devoted to the issue of the interbasin transfer of water.

Despite the immensity of this country, 90 per cent of our population live within 150 miles of the Canada-U.S. border. This concentration has resulted in substantial demands on the water resources of that region.

In contrast, approximately two-thirds of our river flows are carried northward away from our areas of principal development. Here in Ontario 50 per cent of our river flows rise in areas remote from development and flow northward to James Bay to discharge substantially unused to the ocean.

As pressures increase on our southern water resources such as the Great Lakes, these northern waters become even more attractive as a source which, through transfer southward, could alleviate our problems of growth and water demand.

Historically, most large diversions, only a few of which can be termed interbasin, in this country have been designed to increase hydro-electric power generation. Many of these are located in the less populated, more remote areas of Canada where population densities are low and development minimal.

But, these diversions were developed with little concern for environmental and social aspects and generally ignored the native rights of the aboriginal peoples who represented the main residents of the watersheds involved.

Also, these diversions are, in principle, a breach of the riparian system under the common law since they deny the basin population the right of reasonable and undiminished use.

On this continent, no rational federal policy in either Canada or the United States has ever existed for interbasin transfers of water. In the United States, the 1965 Water Resources Planning Act prohibited any basin commission constituted under that Act from even studying interbasin transfers of water. On the other hand, the 1976 Water Resources Development Act directed a study of the depletion of the Ogallala Aquifer in the High Plains Region of the United States to consider the transfer of water from adjacent areas to recharge the aquifer. Some states have statutes prohibiting out-of-state water transfers while permitting transfers within state boundaries.

Here in Canada, several of our provinces have expressed themselves as being unalterably opposed to the export of water to the United States, and, indeed, to other provinces. Canada and Ontario are growing increasingly concerned over the consumptive use by users in the Great Lakes system. The significant and still growing imbalance in that use between our two countries in fact represents export of water from Canada to the United States with no compensation.

Conservation technology and the adequate pricing of water, although not enforced at a sufficient level, are growing in importance as management tools to curb our waste of water resources. In time, however, these will not be enough to satisfy our real growth and the need for more water.

The controversy over the Garrison Dam Diversion, the debate over the possible diversion of Alberta's northern waters to its southern agricultural lands for irrigation, the defeat by public vote of the ratification of the construction of the Peripheral Canal to supplement the north-south transfer of water in the California State Water Plan, and the continuing arguments in the operation of the Central Arizona Water Plan all suggest that interbasin transfers of water will result in a massive political struggle involving water rights, compensation, environmental and social issues and, probably most important, affordability.

With that background, we have four papers to discuss the issue this afternoon: one relates to the experience of water transfer to date; one contemplates the manner of pricing water for transfer; one relates to managing losses to the Great Lakes for future needs; and one represents a mega-buck interbasin transfer project of mind-boggling dimensions that might be implemented to sustain the Great Lakes sytem and the resident population of its basin in the years ahead.

Let us proceed to these interesting presentations.

Dr. J.C. Day
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# A Review of the Biophysical and Socio-Economic Impacts of Selected Diversions: The Ogoki, Long Lake, Churchill-Nelson, James Bay, and Garrison Examples

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## Introduction

The Province of Ontario deserves support and encouragement for sponsoring this conference concerning the potential for, and implications of, diversions of Great Lakes water outside of the basin. It is fortunate that there are a number of existing Canadian water transfers which can be reviewed in terms of potential effects to be anticipated if additional Great Lakes diversions are considered in the future.

This paper is divided into 5 major sections and the first four deal with existing diversions: The Ogoki and Long Lake in Ontario; the Churchill-Nelson in Manitoba; and the James Bay in Quebec. In each case, a review of salient facts and lessons is presented concerning the history and nature of each project, and the biophysical, social and economic changes induced by each. Then, the potential effects of the Garrison Diversion on Manitoba are reviewed. In the final section, conclusions are presented based on these experiences in an attempt to answer two questions: would we undo any of these diversions? Should we plan for, and manage, future diversions differently based on this past experience?

## The Long Lake and Ogoki Diversions

### *Historical Development*

International agreement was crucial to the timing of development of the Ogoki and Long Lake diversions. The Ontario Hydro-Electric Power Commission determined the feasibility of interbasin water transfers from the Hudson Bay drainage to Great Lakes for hydroelectric purposes in the 1924 to 1926 period. Canada initially requested that the United States recognize Canadian proprietary rights at Niagara Falls to any water diverted into Lake Superior in 1925. But not until November 1940 did the United States agree to the immediate utilization of an additional 142 cubic metres per second (cms) in Ontario if Canada would rapidly construct the Ogoki and Long Lake diversions (Figure 1). This was to alleviate energy shortages which could hinder industrial production of material for the World War II defense effort. The confirmation of Canada's right to the diverted water was made permanent by the 1950 Niagara River Treaty (Peet 1978, pages 16-26).

### *The Long Lake Diversion*

The Long Lake Diversion transfers James Bay runoff into the Great Lakes. The project, completed in 1939, redirects Kenogami River flows south through Long Lake via an interbasin diversion channel into the Aguasabon River that empties into Lake Superior. To prevent and reverse northward Kenogami River discharges, the Kenogami River Control Dam was constructed 16km north of Long Lake. At the south end of the lake, an 8.5 km diversion canal was excavated through the height of land. Further downstream, the South Regulating Dam was erected to govern southward diversion flows, averaging 42.5 cms, into the Aguasabon River mouth in the fall of

1948 (Ontario Hydro Operating Department, 1974). The Kimberly-Clark Terrace Bay pulp mill, using the reservoir as a booming ground, was also finished in late 1948 (Figure 2). At that time, the Long Lake Diversion began to perform its present two functions: interbasin pulpwood transportation and power generation locally and in the Niagara and St. Lawrence Rivers.

### *The Ogoki Diversion*

The project rationale was to divert the northward flowing Ogoki River, a tributary of the Albany, southward through Lake Nipigon into the Great Lakes system, providing an average 113.25 cfs flow increment for power production at generating stations on the Nipigon, Niagara and St. Lawrence Rivers. The project, which became operational in July 1943, involved construction of a diversion dam at Waboose Rapids (Figure 3), which raised Ogoki River water levels by 12 m, inundating the river valley and the shores of Mojikit Lake up to the height of land. Here, a 0.4 km diversion channel was excavated and the Summit Control Dam constructed to regulate southern flows. The diverted water augments Little Jackfish River discharges into Ombabika Bay at the north end of Lake Nipigon. Trees were not cleared from the reservoir prior to inundation.

### *Root River Diversion*

Agreement on a third major diversion from Ontario's arctic waters was made in 1958 between Ontario and Manitoba. It provided for the diversion of the headwaters of the Albany River in Lake St. Joseph into the Root River, Lac Seul, and subsequently to the Winnipeg River (Figure 1). Although this project has operated for more than a quarter century, the full range of its costs and benefits has not been analyzed (Lake of the Woods Control Board 1982, 13).

### *An Overview of Diversion Effects*

The Ogoki and Long Lake research findings are mainly applicable to small-scale Precambrian water transfers which are achieved without massive ecological disruptions or major dislocations or impacts on local inhabitants. Caution should be exercised in transferring Ogoki-Long Lake experiences to large-scale diversions, such as the James Bay and Churchill-Nelson, where more severe and widespread ecological changes are possible.

### *Biophysical Changes*

Diversion-induced erosion is a major concern. In reservoirs, diversion channels and receiving water bodies, erosion has increased turbidity, degraded water quality, impaired habitats for predator fish species, and damaged private property and cultural artifacts. Shoreline erosion continues actively in steeply-sloped areas composed of fine glacio-fluvial and aeolian deposits in the Ogoki and Aguasabon Rivers, 40 years after diversion. The most rapid erosion is experienced in diversion channels. Avoidance or removal of easily erodible soils, armoring or vegetating unstable reaches in these conduits, or the creation of reservoirs where appropriate would ameliorate the problem. Environmental inspectors should be appointed to review erosion problems induced by diversions to ensure actions are taken to correct such difficulties immediately, and to arrange equitable compensation for those who experience losses. To enable precise determination of such changes, biophysical and socio-economic conditions in areas to be affected by diversions should be accurately benchmarked prior to construction to enable appropriate adjustments if problems arise.

Failure to clear trees from reservoirs, diversion channels and receiving water bodies produces debris which may require hundreds of years to disappear by natural oxidation. Not only is it an economic waste, but floating and beached timber and standing partially-submerged trees also cause navigation and shoreline access hazards and degrade natural aesthetic beauty. Additionally, drowned vegetation constitutes a hazard for commercial and sports fishing. On the other hand, since specialized habitats are produced for osprey, eagles and other species which prefer to nest near water, some trees should be left in strategic ecological locations. Although initial riverine trout habitats are destroyed, the overall impact of drowned vegetation on fish habitats is unclear. And, while populations of walleye, pike and moose are abundant in Ogoki Reservoir areas, there is no evidence of effects on caribou and other animals living in the diverted watershed.

It is necessary to guard against possible movement of lamprey, undesirable exotic fish species, and parasites into new watersheds where they are not present prior to diversion. For example, it was fortuitous that lamprey, carp and other foreign species were not able to enter the Albany River system via the Ogoki or Long Lake diversion systems. This occurred because Ontario Hydro had constructed power dams prior to the entry of these fish into Lake Superior, or natural obstructions prevented interbasin migration.

### *Socio-Economic Changes*

From 1943 to 1974, net economic benefits of the Ogoki-Long Lake diversions exceeded $220 million in 1974 dollars, excluding power benefits accruing to New York and Quebec. Ontario could have achieved even greater financial returns if international and interprovincial agreements with Michigan, New York and Quebec had been made to reimburse the Province for the diverted water which passes through the turbines on the St. Mary's, Niagara and St. Lawrence River systems.

Another problem concerns credit for diverted water. Over the 1943-72, period, the diversions averaged 160 cms, or 18.7 cms more than originally anticipated. Under the 1950 treaty, Canada presently has not had use of half of this surplus at Niagara, or 9.3 cms. Although the United States agreed in principle on four occasions (1932, 1938, 1940 and 1941) that rights to water diverted into the Great Lakes shall be vested in the country from whose territory it comes, none of these agreements received Senate approval (Friesen, 1981, 203-209). As a result, Canada currently fails to receive credit for about 9.3 cms at Niagara and for any of the diverted water in the St. Mary's and St. Lawrence Rivers because of the failure to establish a comprehensive International Great Lakes Basin water agreement.

Viewed from this perspective, there is clearly a need to incorporate more socially responsible policies into project operations. For example, it is inequitable to develop and export hydro-electricity from the Ogoki, Nipigon and Long Lake basins to supply low-cost power to users outside the diverted watershed when residents of the Gull Bay Reserve, Armstrong and other local settlements in the diverted watersheds must import oil and run diesel generators to produce electricity at much higher costs.

Another concern relates to Ontario Hydro northern water rental payments to the Ontario Government for water power lease agreements. Some of these funds should be used in the north to ameliorate negative effects of diversions and other resource use problems. Environmental degradation attributable to flooded forests, log driving reduced fish stocks and local energy supplies could all be improved greatly by greater capital investments funded from provincial water rental taxes.

Compromise in choosing among management alternatives will always be necssary, particularly where specific hydro-electric operational procedures could cause serious or irreparable damage to other resource users. For example, water levels should not be maintained artificially high or low for extended periods if widespread erosion or fish egg mortality results. Bypass facilities could be built around dams to facilitate movement by travellers. Tourist outfitters and other resource users should be notified in advance of major changes in water flow direction and magnitude to permit adjustments in water use plans. All of these problems are reported or alleged in the study areas.

It is difficult to dispute the overall social usefulness of the projects when such enormous economic benefits are compared to the more minor, yet manageable, diversion-created difficulties and inconveniences considered above. Moreover, forestry is the main Long Lake area industry, and its development would have been delayed many years without the diversion. The Long Lake Diversion, through the provision of power and a transportation facility, is responsible for the siting, construction and growth of the Kimberly-Clark pulp mill and the Town of Terrace Bay. The social evolution of the Town of Longlac is also directly related to the Long Lake Diversion for long handling. While some Ogoki-Long Lake resource users are still partially hindered by diversion operations, in most cases ecological or social impacts have moderated or stabilized, and resource users have adapted or remedial measures have been taken.

## Churchill River Diversion (CRD)

Faced with the choice of developing the hydro-electric potential of its northern rivers or thermal electric generating facilities in the south, in 1966, Manitoba chose to divert the Churchill (CRD) and to regulate Lake Winnipeg outflow (LWR) to implement its northern hydro-electric option. Manitoba Hydro was licenced to undertake the CRD in 1972, and the diversion was operational in 1977.

The 250,000 km$^2$ Churchill River extends across the northern half of Alberta, Saskatchewan and Manitoba. The diversion is made from South Indian Lake (SIL) in the Churchill River, and it has 3 major components. A control dam at Missi Falls, the natural SIL outlet, is used to raise the lake level by 3 metres. A channel excavated from South Bay of SIL to Issett Lake allows up to 850 cubis metres per second (cms) to be transferred into the 300 km system comprised of the Rat, Burntwood and Nelson Rivers. The Notigi control structure on the Rat regulates flow into the Burntwood-Nelson system (Figure 4).

Outflows from SIL, which previously averaged 991 cms, will be reduced to 43 cms during the ice-cover period and 14 cms during the open water season. The average Churchill River flow entering Hudson Bay will be reduced from 1274 cms to 510 cms. To March 1984, the cost of these facilities, as well as compensation and mitigation actions to reduce negative environmental effects, has been $228 million. Compensation claims currently are unknown, but they could add an additional $100 to $400 million to the total.

Up until 1979, 2252 MW capacity had been installed in the Lower Nelson River in the Kettle and Long Spruce Generating Stations, at a cost of $834 million, partly to use the water diverted from the Churchill. An additonal $100 million was invested in the Limestone Generating Station, but this plant was temporarily abandoned in 1978 due to falling energy demand (Tritschler 1979, 69, 179, 241).

### *Power Transmission*

Lower Nelson River power is carried to southern Manitoba over two identical 900,000 and 1,000,000 direct current transmission lines which are approximately 900 km long. Initial service started in 1971. These were funded by the Government of Canada, and will be repaid over a 45-year period. The total cost exceeded $300 million. In addition, the Nelson River plants are also served by a 230,000 volt alternating current transmission line. Ultimately, the two systems will transmit up to 3420 MW, sufficient for the output from Kettle, Long Spruce and Limestone (Tritschler 1979, 37, 41, 404; Manitoba Hydro, 1981).

By 1984, Manitoba had constructed interties capable of carrying 1500 MW of power to the United States, 150 MW to Ontario and 375 to Saskatchewan. These tie lines permit the export of surplus energy and increase the security of supply in Manitoba by permitting imports.

### *Biophysical Changes*

Two environmental impact assessments were undertaken in an effort to predict the effect of impounding, and diverting, water from Southern Indian Lake. A team of scientists from the Freshwater Institute of the Federal Department of Fisheries and Oceans in Winnipeg has greatly extended our understanding of the biophysical consequences of impounding and diverting riverine lakes in areas of discountinuous permafrost of the Precambrian Shield (Hecky et al. 1984). They conducted detailed monitoring programs over a 10-year period to measure change and determine the accuracy of predictions.

Predicted effects based on the best scientific theory successfully identified the nature of many modifications which occurred, such as increased shoreline erosion, littoral sedimentation, turbidity and phosphorus availability, as well as decreased light penetration, visibility and light limitation of primary production. However, existing theory was inadequate to predict a decrease in the lake water temperature and socially significant changes related to increased mercury content in fish flesh, rapid declines in the quantity and quality of whitefish taken in the commercial fishery, and the need for compensation programs to keep the commercial fishery economically viable.

### *Shore Erosion*

As a result of impoundment, the area of Southern Indian Lake increased from 1977 to 2391 km$^2$, the total volume from $16.84 \times 10^9$ to 23.38 $10^9$ m$^3$, and the total shoreline length from 3665 to 3788 km. Prior to flooding, 88% of the shoreline was bedrock controlled and only 5% was actively eroding; immediately following inundation, bedrock occurred on only 15% of the shoreline because the post-impoundment water surface intersected glacial and organic deposits on 85% of the new shorelines. Onshore waves initiated substantial erosion on all shores exposed to more than 1 km of offshore fetch. This has caused retreats of up to 10m/yr, annually removing up to 25 m$^3$ of material per m of shoreline (Bodaly et al. in press). It is not clear, at present, how long it will take to re-establish a stable shoreline around most of Southern Indian Lake. Where permafrost was encountered in glaciolacustrine clays and fine-grained tills, as much as 80% of this eroded material was initally deposited near shore; the remainder went into suspension and significantly increased offshore sediment concentrations by 2x to 5x. This could negatively affect fish reproductive success.

### *Fisheries*

The catch per unit effort of whitefish on the traditional fishing grounds decreased after impoundment. As a result, there was a redistribution of commercial fishing effort, and the total whitefish catch was maintained for 5 years after flooding by increased fishing effort, but eventually effort declined and total catch declined. The fish quality also decreased due to darker colour flesh and high cyst counts. Mercury concentrations in muscle increased soon after inundation in all commercial species following flooding. Pike and pickerel exceeded the Canadian marketing limit for mercury concentration in flesh and, in some cases, exceeded the export marketing limit of 1.0 ug per gram. The rapid increase of mercury in fish is a major problem which must be considered in all future proposed reservoirs (Bodaly et al. 1984).

### *Social Impacts*

Among the worst aspects of the planning for the Churchill River Diversion was the insensitive manner in which the affected communities were handled in the process. Manitoba Hydro took the position that its responsibility was limited to repair or replacement of facilities that were directly affected by the diversion; compensation for indirect effects was the responsibility of the Provincial Government (Tritschler 1979, 209).

The high-level alternative CRD was conceived and planned with inadequate attention to environmental and social effects. When Hydro initially applied for a licence in April 1968 to build a high-level diversion, the project would have raised Southern Indian Lake by 10.6 m, flooded Indian lands, and required the resettlement of several hundreds of people. Those to be affected were not consulted nor were procedures and funds for resettlement included in project cost estimates. Organized opposition led to the rejection of this poorly conceive proposal. Indeed, later studies by Manitoba Hydro revealed that the scheme would not have been workable and that the impact on the people and the environment would have been totally unacceptable. Economic costs and benefits of the project had never been studied in detail (Tritschler 1979, 71, 81, 84).

### *The Northern Flood Agreement*

Although the low-level Churchill River Diversion alternative eventually constructed was committed on December 1, 1972, neither Manitoba Hydro nor the provincial government had formulated a plan to compensate communities and individuals to be negatively impacted. Five native communities to be affected by the project formed a legal corporation in 1974, the Northern Flood Committee Inc. (NFC). In July of that year, they threatened to obtain an injunction refraining Manitoba Hydro from proceeding with the development. Subsequently, NFC began negotiating with the federal and provincial governments in 1974 and 1975 concerning appropriate compensation. But until a mediator was appointed in February 1976, neither the provincial government nor Hydro would admit that reserve lands would be flooded by CRD. Finally, the negotiator formed a compact concerning compensation, the Northern Flood Agreement (NFA), in December of the same year among four parties: the Northern Flood Committee, the Government of Manitoba, Manitoba Hydro and the Canadian government, represented by the

Department of Indian Affairs and Northern Developemtn (DIAND). The main provisions of the agreement were for the exchange of provincial crown land for any reserve land to be flooded, on the basis of not less than 4 acres for each acre affected, exclusive use of certain land set aside for each Indian band, compensation for loss of income from trapping and fishing, and a $5 million contribution by Hydro and the federal and provincial governments to a development corporation to be used for the benefit of the affected communities (Manitoba et al, 1977).

Compensation payments until December 1983 for both the diversion and Lake Winnipeg regulation were $46.7 million. Most of this was for remedial works to replace improvements detroyed by the projects, although $4.5 million was also spent to keep trappers and fishermen working in their traditional employment (Manitoba Hydro, December 1983). However, the affected communities have submitted claims for much damage which could substantially exceed the level of compensation paid to date.

In effect, the concerns of the affected communities and the protracted and bitter negotiations among the Northern Flood Committee, the Manitoba government and Manitoba Hydro were the result of inadequate engineering and environmental knowledge. Indeed, the Northern Flood Agreement was not achieved until the diversion was operational. To date, the cost of implementing the agreement has never been determined.

### *Economic Considerations*

With the advantage of hindsight, several decisions during the planning stage contributed to the ultimate profitability of CRD. Costs were consistently underestimated, and firm energy sales contracts were not arranged prior to construction. Although significant revenue is generated by diversion-related energy, Long Spruce exports are made without profit because of the comparatively low revenues received for the interruptible power sold (Tritscher 1979, 410). For example 41% of system energy was exported in 1982/1983 at an average return of 13.8 mills per kwh, while Manitoba customers paid an average of 20 mills (Manitoba Hydro, November 15, 1983). And provincial energy rates, currently among the lowest in Canada, have been set so that Manitoba Hydro has incurred an operating deficit in 6 of the past 10 years. Partially as a result of the diversion and the Kettle, Long Spruce and Limestone projects, Manitoba residents carry a debt burden per capita that is second highest among Canadian provinces (Tritschler 1979, 26). On the other hand, the capacity value of Kettle and Long Spruce add considerable reliability to the Manitoba Hydro system.

Several factors make it impossible to predict the long-term profitability of the Churchill River Diversion. To the present time, only 30% of the usable head along the diversion route and the Lower Nelson has been developed. If firm domestic or export contracts for the remaining potential development were available, the diversion cost could be spread over more installed capacity, and the average return from export sales could increase dramatically. On the other side of the ledger, the ultimate cost of compensation and mitigation is yet to be determined. Finally, the actual amount of the financial benefit or loss associated with CRD cannot be estimated because realistic cost estimates for alternative projects were never developed to permit such a comparison (Tritschler 1979, 19).

There are clearly major lessons to be learned from the Churchill Diversion experience. However, it is important to note that a judicial inquiry found little fault with the technical expertise of the Manitoba Hydro professional staff. The Tritschler Commission attributed most of the problems encountered to lack of direction and control by the provincial government and inappropriate judgements and decision making procedures followed by senior Hydro officials. All of these problem areas in the corporation have been strengthened since the judicial review.

## The James Bay Project

In 1971 the decision was made to develop the hydro-electric potential of the remote and sparsely-settled river basins draining into James Bay. Over the next 4 years, the alternatives were examined in detail and the decision was made to begin initially with the massive potential of La Grande River Basin which has an average flow of 1700 cms. This represented an enormous commitment of money and manpower. Approximately 1000 km north of Montreal, the La Grande River drops 376 m over its 800 km course from east to west before reaching James Bay. Its 98,000 $km^3$ drainage basin is more than twice the size of Switzerland (Figure 5) (Societe d'energie de la Baie James 1983, 31).

To maximize the output from hydro-electric stations, water was diverted into the La Grande from adjacent drainages. From the south, 87% of the Eastmain Basin is redirected into the LG2 reservoir, and 27% of the Caniapiscau enters the LG4 reservoir to flow through all three powerhouses. Collectively, these diversions, which add an average 1600 cms, nearly double the natural flow of the La Grande River. The eight main dams and 198 dike which were required to form the five major reservoirs of the La Grande complex collectively are 125 km long and required 150 million $m^3$ of fill (Societe d'energie de la Baie James 1983, 33-55).

Three hydro-electric plants were constructed in Phase 1 of the project: La Grande 2, 3 and 4. With an installed capacity of 5328 MW, LG2 is the most powerful underground generating station in the world, and it provides 35.8 billion kilowatt-hours of energy annually. LG2 and LG3, with a collective capacity of 4954 MW, produce only 74% of the LG1 yearly output. The first energy was generated at LG2 in 1979, and LG4 is expected to be completed in 1987.

Five 735,000-volt transmission lines will carry the energy from the Phase 1 plants over nearly 5000 km of lines to Quebec's urbancentres and interties with Ontario, New Brunswick and the United States. This system will cost approximately $3.7 billion. The total Phase 1 cost is estimated at $14.6 billion.

### *Biophysical Effects*

Many changes induced by the Ogoki, Long Lake and Churchill-Nelson diversions reported above were also observed in the James Bay project. But the approach to deal with them has been significantly different. Four major groups have been involved in studying the biophysical environment. Initially, the Cree bands engaged scientific and legal advisors to assist them in establishing an aboriginial rights claim to the project territory and in determining what impacts the proposed projects would have on their land.

Shortly after the James Bay project was announced, a federal/provincial task force recommended a program of biophysical inventories be undertaken to obtain baseline information for impact assessment in the project area. An ambitious 7-year study was initiated to evaluate the fresh water, marine and terrestrial environments, the atmosphere, geology, flora and fauna. These data were subsequently used in locating transportation corridors, forestry planning and a beaver trap-out and relocation program, although they could not be applied to land use planning because the information was not available in a manageable form at the time needed (Society de Developpement de la Baie James 1982).

As part of the James Bay Agreement, a joint corporation the La Grande Complex Remedial Works Corporation (SOTRAC), was formed by the Cree and the James Bay Energy Corporation. Its Board of Directors is composed of 5 members: 2 appointed by the Cree, 2 from the James Bay Energy Corporation, and a fifth non-voting Cree member. The rationale for this body was that potential impacts and required remedial measures could not be predicted at the time of the James Bay Agreement. This corporation was created to plan, evaluate, execute and operate remedial works related to Cree fishing, hunting and trapping. A fund of $30 million was established to conduct this work, with an initial annual payment of $250,000 in 1976 which increased up to $2.5 million, and a final payment of $15 million in 1986 (Canada 1982, Section 8.9). This adaptive strategy has been beneficial in responding to community and individual requests for assistance; the corporation has never had to submit a dispute to arbitration (SOTRAC, annual reports).

Another innovation concerned the creation of a Department of the Environment within the James Bay Energy Corporation with a mandate to ensure that all laws and regulations for environmental protection are met, and that ecological considerations received the same consideration in project design as technical and economic matters. They undertook major studies beginning in 1976 to determine corrective measures needed to reduce biophysical impacts concerning means of natural deforestation, floating peat bogs, fisheries, the establishment of flooded terrestrial habitats , and the revegetation of disturbed sites (Soucy et al, 1977). Its studies and remedial works have continued to the present time.

An extensive monitoring program is underway to trace the effects of the James Bay hydrological modifications on fisheries populations. Although it is too early to detect all changes, pike populations increased dramatically following reservoir filling. Walleye did not begin to reproduce for 5 years after flooding of the LG2 reservoir, even though spawning lanes had been preconstructed. In the Opinaca Reservoir where there was less inundation, this has not been a serious problem (Roy 1982).

One of the most important fisheries problems that developed was the release of mercury from flooded land. Mercury levels in fish in the reservoirs exceed the Canadian consumption limits by 2 to 3 times. Because of the enormous distances to southern markets, a commercial fishery had not been established in the area; the fish were used for local subsistence needs. It is unknown how long will be required for mercury levels to return to normal so that new patterns of subsistence and sport fishing may develop.

In general, erosion and turbidity problems are not major problems in the reservoirs and diversion channels in the James Bay project in comparison to the Southern Indian Lake experience. Where erosion did occur after reservoir filling, shoreline armoring occurred rapidly. Cattails are being planted in Sakami Lake to reduce erosion and create habitat. Doubling the La Grande flow downstream from LG2 also doubled turbidity, although the level remains relatively minor. The major sedimentation concern has arisen on the Eastman below the spillway which prevents all but flood flows. Sills were required to prevent downcutting, as turbidity was creating a problem for the Village of Eastmain. Sedimentation is also a problem where salt and freshwater meet near the mouth of the Eastmain; flushing with freshwater releases will be attempted in 1984 to remove the deposits (Roy 1984).

Finally, logs in the reservoirs and flooded lakes have been a major concern. In critical areas such as the rims of reservoirs, future spawning grounds and the banks and mouths of rivers, trees were originally cut and burned; elsewhere, the action of ice was used to break the stems. A floating incinerator is currently working in the Eastmain-Opinaca Reservoir in an effort to dispose of the floating debris.

A major effort is underway to revegetate disturbed sites associated with Phase 1 of the James Bay project. Approximately 5700 hectares are being planted with seedlings, and an additional 300 hectares with grasses.

## *Social Changes*

Approximately 6650 Cree-speaking people lived in Northern Quebec in eight villages, five situated along the James and Hudson Bay coast and three 500 km inland. An additional 4386 Inuit live in 15 villages north of the Cree (Canada 1979, vi; 1982, 5). They were isolated and there was virtually no communication among the Cree Bands. When the decision to build the James Bay hydro-electric project was announced in 1971, the initial Cree reaction was one of shock at not having been informed and consulted, at the extent of inundation of their hunting lands, at the impact the project would have on wildlife that provided a substantial portion of the Cree diet, at the impact on their hunting activities, at the social consequences of the massive influx of non-indigenous workers to the territory, and at the uncertain economic effect on the Cree (Feit 1980, 159). Ultimately, the potential effect of the project on the Indian population was to unite these bands into the Grand Council of the Cree of Quebec.

In response to the initial Cree attempt to discuss the projects, the Quebec Government took the position in 1972 that the plans were not negotiable and that the indigenous people had no special rights. In an effort to force a decision concerning their rights to the land, the Cree and Inuit to be affected by the project sought a court injunction to stop construction work in 1972. Justice Malouf granted the injunction the following year, and ruled that construction could not proceed without prior agreement of the Indians and Eskimos (Malouf 1973, 38). Even though a higher court ruled to suspend the injunction within a week, the Malouf judgement had made it impossible for Quebec to ignore the Cree and Inuit case; within five days of the Malouf decision, Quebec announced it was ready to negotiate, and within two weeks it presented the Cree and Inuit with a proposed settlement.

The James Bay and Northern Quebec Agreement was signed in November 1975 by the James Bay Cree, the Inuit of Northern Quebec, the Governments of Quebec and Canada, the James Bay Development Corporation and Hydro Quebec. The agreement was a recognition of aboriginal land rights. From the perspective of the native parties, the main aim of the settlement was to give them the means of ensuring their cultural vitality and of preserving their traditional way of life while taking advantage of the economic opportunities and benefits arising out of the development of Quebec's northern territories. The Cree and Inuit obtained protection of their traditional hunting, fishing and trapping rights and a priority on the use of certain animals in the region. Certain lands were set aside for their use as traditional reserves and village corporations. The Cree secured promises to have modifications made to the James Bay project, especially in the LG1 dam location, of remedial works to minimize environmental damage, and cash compensation of $232.5 million divided proportionally between the Crees and Inuit and paid over 21 years until 1977 (Government of Quebec et al, 1976).

In order to implement the agreement, the Cree and Inuit had to create an entirely new governmental structure. The agreement provides for several dozen committees, municipal corporations, authorities, boards and other legal entities through which it was intended the native people would gain control over their affairs. For example, the Cree Regional Authority controls the administrative structure of the bands. Special purpose boards have been created to administer programs related to health and social services, schools, income security, housing, arts and crafts, trappers and construction. Natives are also intimately involved in the administration of justice and policing. Today, the Indian communities are physically integrated into the communications and transportation networks of the province, and they can communicate with each other. All of these changes were rapid innovations induced by the project (Canada 1979, 29-38). During the first six years until March 31, 1981, the Federal Government spent $178 million on programs, services and benefits for the native parties (Canada 1982, 106).

### *Agreement Implementation Problems*

Major disputes have arisen between the native parties and the governments of Canada and Quebec related to the failure to fulfill their obligations under the agreement. Basic to this feeling is the realization that the value of the compensation package will shrink a minimum of 26% as a result of inflation during the implementation period; that urgent housing, school and other infrastructure needs would not be met quickly, that health care has been inadequate, that economic development has not been stimulated, that there has been inadequate funding to handle local and regional administration, that the system of justice is inadequate, and that there has been inadequate attention paid to implementing and reporting progress on the agreement (Canada 1982).

### *Economic Impacts*

Plans on which the James Bay development were based did not materialize due to the world recession of the early 1980s when domestic consumption did not grow at the predicted rate. Since 1982, Hydro Quebec has spilled the equivalent of between 2 and 13.8 billion kwh of energy annually in their system because of a deficiency of provincial demand and export intertie capacity (Hydro Quebec 1982, 26, 37, 64). With a $16 billion debt and the need to refinance $2 billion of interest charges, the utility must concentrate on reducing its financial obligations. This will be done by developing new markets in Quebec, particularly for domestic heating. Potential export sales to Vermont, the New England Power Pool and the New York Power Authority could also substantially reduce the 22 billion kwh annual surplus which will be available in 1987 when Phase 1 of the James Bay project is completed (Yukon 1984, 28).

## Garrison Diversion Unit (GDU)

### *Historical Development*

Construction of the Garrison Diversion Unit was authorized by the United States Congress in 1965. The purpose of the project was to irrigate 60,700 ha, to provide municipal and industrial water supply to 14 communities, and to provide new recreation and fishing opportunities and wildlife habitat in North Dakota using water diverted from the Missouri River. Since many features of the Garrison Diversion Unit (GDU) are in the Hudson Bay drainage basin, most drainage and waste waters from the irrigated areas would flow into transboundary streams and could adversely impact Canada (I.J.C. 1977, 1).

Canada has consistently opposed GDU. The basis of the objection is Article IV of the Boundary Waters Treaty of 1909:

> *It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other.*

GDU was authorized by the United States Congress in 1965 without consulting Canada. The Snake Creek Pumping Plant, the McClusky Canal and the Longtree Reservoir, the principal supply works, have been under construction since 1968 by the Bureau of Reclamation, an agency of the U.S. Department of the Interior (Figure 6). The proposed project would lift Missouri River water from Lake Sakakawea, formed by Garrison Dam, via the Snake Creek Pumping Plant into Lake Audubon, an adjacent impoundment. Waters from Lake Audubon would flow by gravity through the 118.5 km McClusky Canal across the continental divide into Lonetree Reservoir. The Lonetree Reservoir, with a storage capacity of 523,000 cubic decameters ($dam^3$), would be formed by the Lonetree Dam on the upper Sheyenne River and by Wintering Dam in the headwaters of the Wintering River, both in the Hudson Bay drainage basin, and by the James River Dikes on the continental divide and also at the headwaters of the James River in the Missouri River drainage basin. The reservoir is so situated that water from it can be conveyed by gravity into the Souris, Red and James River basins as well as the Devils Lake Basin (I.J.C. 1977, 13).

Up to 1977, construction activities focused on completing the Snake Creek Pumping Plant, the McClusky Canal was 90 per cent complete, and the Wintering Dam was 70 per cent complete. Construction of Lonetree Dam and the James River Dikes, and on those components downstream, had not yet begun.

### *GDU Affected Areas*

The Canadian drainage systems that would receive GDU waters consist of the Souris, Assiniboine and Red Rivers and Lakes Manitoba and Winnipeg. Manitoba officials, supported by the federal government, expressed alarm in the late 1960s that leaching of irrigated soils of GDU would degrade water quality throughout the affected Canadian system. It was feared that return flows would increase the amount and frequency of flooding. There was also concern that the water conveyance systems of the Garrison Diversion Unit would provide a direct connection between the Missouri River and the Hudson Bay drainage basin, thereby enabling the possible introduction of foreign fish, fish eggs, fish parasites, fish diseases and other biota into Manitoba waters. This could have an irreversible adverse impact on existing aquatic systems, on commercial and recreational fishing in Manitoba, and on native bands dependent on subsistence fisheries, and cause a major reduction in wildlife habitat in North Dakota (I.J.C. 1977, 1-2; I.J.C. 1978).

### *Initial Internatinal Actions*

During the 1960s and early 1970s, a pre-existing body of the I.J.C., its International Souris-Red Rivers Engineering Board, informed the Commission of progress in the planning and construction of the Garrison Diversion Unit. Congressional authorization for GDU construction was enacted in 1965. Following an expression of alarm by Manitoba regarding the potential transboundary effects of the project, these concerns were crystallized in a Canadian aide-memoire to the U.S. Government in April 1970. Subsequently, on the basis of reports prepared by the United States Bureau of Reclamation, Canada submitted a diplomatic note in October 1971 reiterating its concerns.

In October 1973, Canada, in a diplomatic note, requested urgently:

> *. . . that the Government of the United States establish a moratorium on all further construction of the Garrison Diversion Unit until such time as the United States and Canadian Governments could reach an understanding that Canadian rights and interests have been fully protected in accordance with the provisions of the Boundary Waters Treaty.*

In its February 1974 reply, the Government of the United States stated that it recognized its obligation under Article IV of the Boundary Waters Treaty to avoid transboundary pollution, and no construction affecting Canada would be undertaken until it was clear that this obligation would be met (I.J.C. 1977, 7-9).

In 1974, officials of both countries discussed Canadian concerns over potential water quality degradation and the associated effects on health and property in Canada. They agreed to recommend to their own government an appropriate mechanism to undertake a joint examination of GDU to ensure that provisions of Article IV of the

Boundary Treaty were honoured. On October 22, 1975, the governments of Canada and the United States referred to the International Joint Commission the matter of transboundary implications of the Garrison project. The Commission immediately established the International Garrison Diversion Study Board.

### *The International Joint Commission Study*

The I.J.C. submitted its report to the governments in September 1977. Because the GDU could not, with certainty, prevent the transfer of biota and disease which could cause severe and irreversible damage to the ecosystem and, in particular, to the commercial and sport fisheries in Canada, the Commission recommended that those portions of the project which could affect waters flowing into Canada not be built at that time.

### *Recent Developments*

Following receipt of the I.J.C. report, the next Canadian initiative was a formal statement and discussions with U.S. Officials in a March 28, 1979 response to a new GDU design re-evaluation and modificaiton proposed by the Bureau of Reclamation. It would reduce the irrigated areas dramatically from 100,000 and 40,000 ha. Based on the I.J.C. study findings, Canada again flatly rejected the proposal. The United States response was to continue to honor its obligations under the Boundary Waters Treaty not to pollute Canadian waters (Canada, Washington Embassy, March 28, 1979). A major break in planning for the Garrison Diverison came on October 29, 1981. The Bureau of Reclamation proposed a completely new plan which would not permit any Missouri River water to enter the Hudson Bay basin (Porter, January 1982). However, the U.S. Bureau of Reclamation submitted a revised, scaled-down version of its initial plan again on August 23, 1983, in which a preliminary 10-year plan to develop 34,400 ha was proposed. In an effort to placate the concerns of Canadians and wildlife biologists, the return irrigation water flow which would have reached the Sheyenne River basin would be diverted to the James River in the Missouri River system. Lonetree Reservoir would be operated 3.04 m lower than initially planned, and a fish screen would not be required on the McClusky Canal because water would not flow to Canada from the project. Wildlife habitat losses would be mitigated by intensive management of fewer hectares, as opposed to hectare-for-hectare replacement of wildlife losses proposed in 1979 (U.S. August 23, 1983, 1982).

### *Implications of this Experience*

For nearly 20 years, the U.S. Bureau of Reclamation has been attempting to implement a massive diversion project, primarily for irrigation benefits. Largely as a results of impartial investigations by the International Joint Commission, this project has been blocked until all international water transfers which could detrimentally affect

Manitoba interests are prevented. This is an example of how potential diversions should be analyzed prior to implementation to ensure that other interests are not negatively affected.

## Towards a New Strategy for Managing Hydro-Electric Diversions

Based on the 5 projects studied, what should be said in response to the question: given the opportunity, would we undo the rivers already diverted? Clearly, the answer is no, but hopefully we would do many things differently, in a more economically gainful, socially acceptable, and physically sensitive manner. A number of recommendations to achieve this goal follow:

1. We built too much hydro-electric capacity too quickly. The James Bay and Churchill-Nelson projects have both demonstrated the dangers of straight-line extrapolation of past energy demand trends. While a risk-aversion strategy could potentially result in short periods of energy shortage, it would be far less costly for society to use pricing, conservation strategies and short-term importation to balance supply and demand. This would permit more energy facilities to operate at or near their safe capacity while returning a reasonable profit on investments. Such an approach would have the added advantage of removing some of the boom and bust characteristics for this sector of the construction industry and the related labour force.

2. Export capacity should only be built when firm contracts are in hand, to ensure that such investments will be profitable. As we have learned, there is a high level of social and ecological disruption associated with a diversion. The price of energy to the importer should reflect the cost of all compensation and mitigation actions, generation and transmission facilities and the risk of cost escalation during the construciton period, which may last more than a decade. We should attempt to ensure a profit to compensate for all of the risks and opportunity costs involved.

3. The price of energy to domestic consumers should also incorporate all of the costs involved in generation, and much more needs to be done to encourage conservation. Such a strategy would decrease the rate at which diversions must be constructed in the future.

4. Provincial governments should establish an independent agency in charge of all energy matters. Such a body should be made responsible for selecting an appropriate provincial mix of energy sources, for developing a clear and unequivocal mandate for electrical utilities, and for ensuring that technical, economic, biophysical and social concerns all receive an appropriate level of attention during the planning, development and operation of diversions.

5. We must pay more attention to the needs of local residents disrupted by diversion. Particularly in remote areas where native bands are unfamiliar with southern institutions and customs, a long lead time is necessary for education, negotiation, planning and compromise. Serious effort should be made to arrange adaptive agreements and compensation arrangements before construction begins, so that problems which emerge during construction and operation can be corrected or mitigated immediately.
6. The style of future settlements with native groups should be based on mediation and compromise rather than the legalistic confrontation approach adopted initially in the Churchill-Nelson and James Bay agreements. It is now clear that, when treated unjustly, native groups can successfully use the legal system to halt construction and engage utilities in costly litigation. The SOTRAC joint decision-making approach involving the Cree and the James Bay Energy Corporation is a promising model to deal with emerging problems where rapid adaptation to project changes is necessary. The James Bay Agreement deserves careful study to determine the rate at which native groups can assume control over their local and regional governments, education, health care, legal, transportation, economic development systems and the kinds of training they will need to do this work efficiently.
7. Early public discussion and strategic planning are needed to develop long-term policies for northern rivers which potentially could be modified by diversions. Gradual attrition of resources such as canoe routes followed by trappers and fur traders, trading posts, native artifacts white-water canoeing opportunities, fish habitats, mineral deposits and the aesthetic beauty of natural landscapes should be avoided. River regulation should be confined to designated watersheds, and others should be permitted to evolve under natural processes.

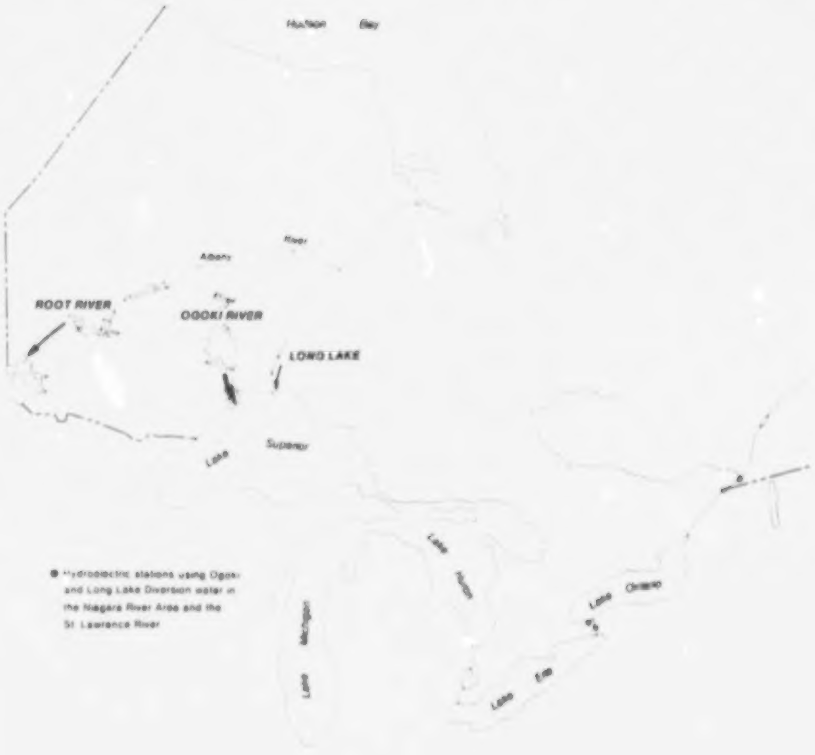

Hudson Bay
Albany River
River
ROOT RIVER
OGOKI RIVER
LONG LAKE
Lake Superior
● Hydroelectric stations using Ogoki and Long Lake Diversion water in the Niagara River Area and the St Lawrence River
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie

Figure 1 The Ogoki and Long Lake Diversions

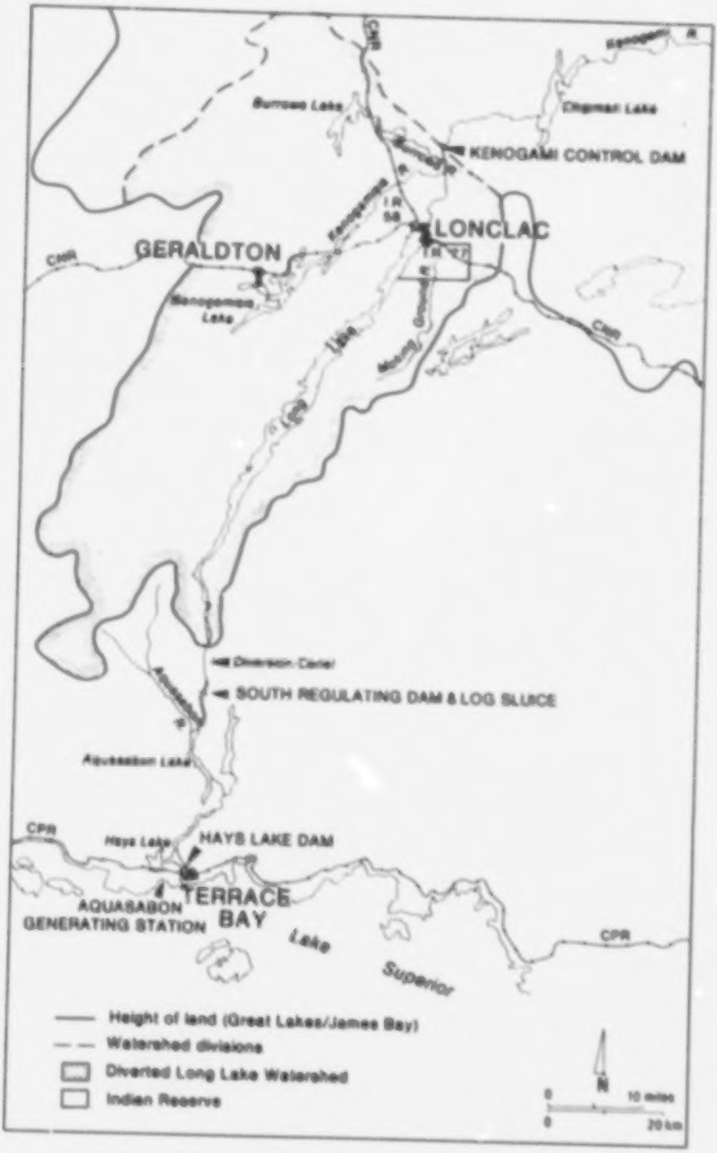
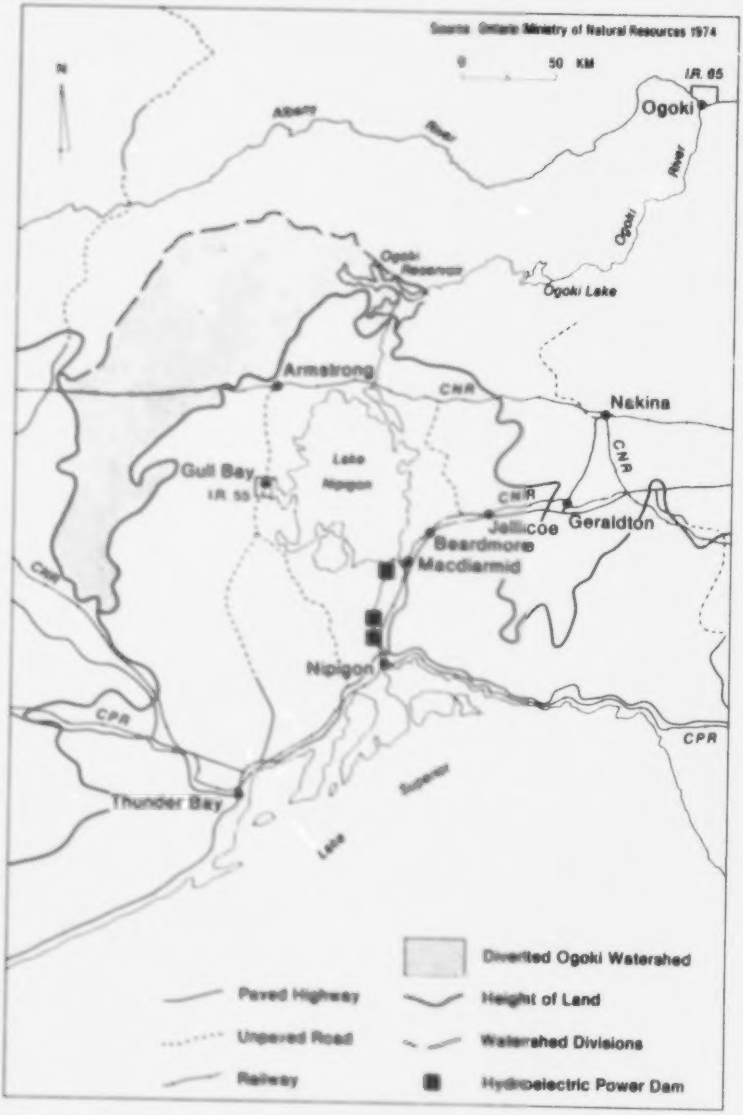


Figure 2. The Long Lake Diversion



Source: Ontario Ministry of Natural Resources 1974

Figure 3. The Ogoki Diversion

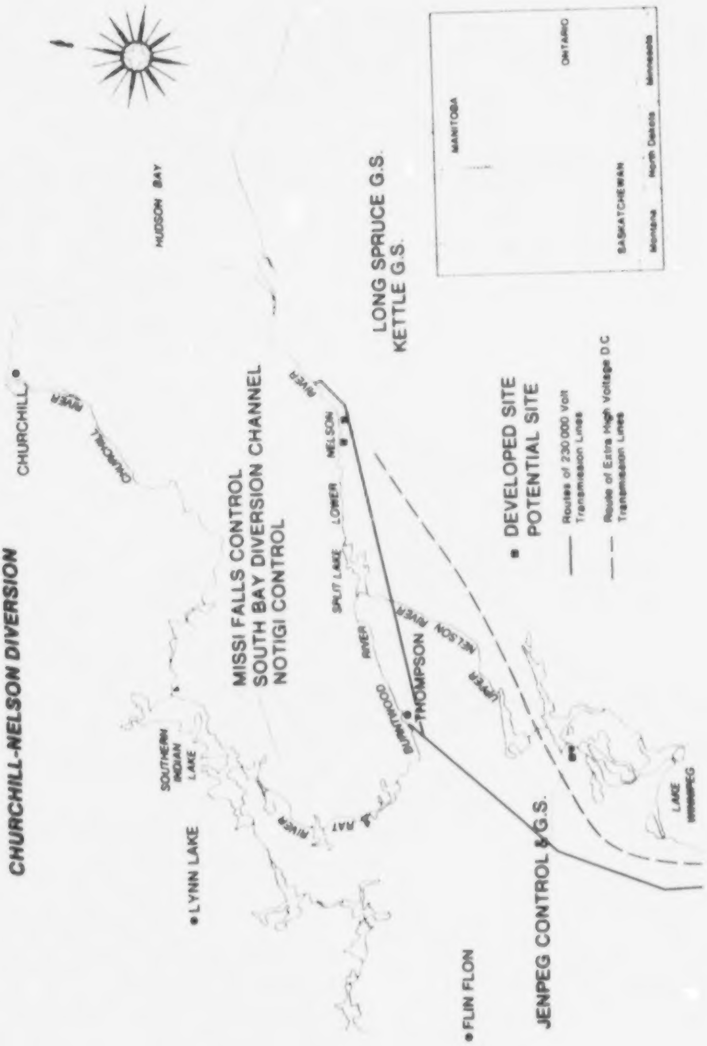


Figure 4. The Churchill-Nelson Diversion

JAMES BAY PROJECT

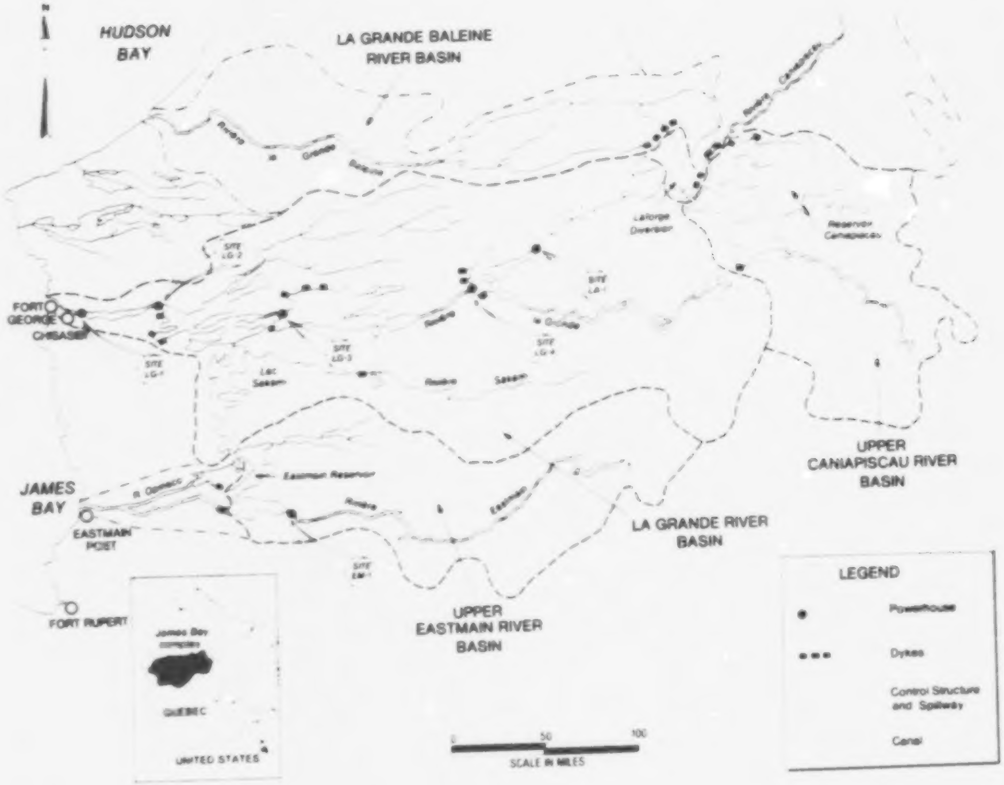


Figure 5 The James Bay Project

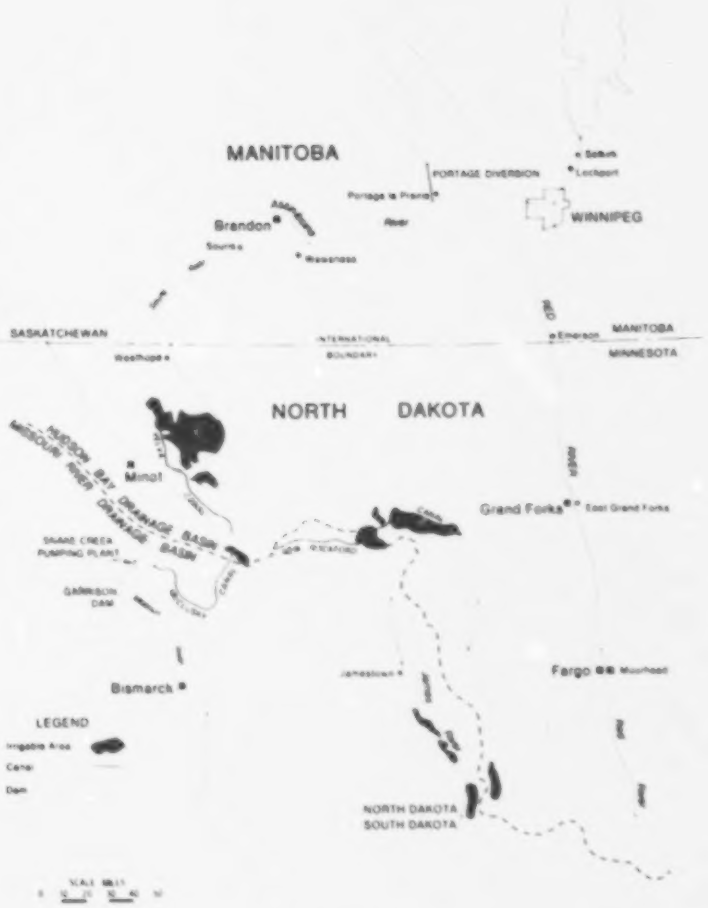


Figure 6. The Garrison Diversion Unit

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# The Value of Water as a Commodity

*Dr. Mitchell took his B.A. and M.A. degrees at the University of British Columbia, followed by a Ph.D. from England's University of Liverpool. His research interests focus on the social and economic aspects of water management, including the development of systematic and comprehensive resource strategies. He is now serving as the National Director of the Canadian Water Resources Association.*

## Abstract

North American society has traditionally undervalued water as a commodity. This policy has led to wasteful and inefficient use, as well as difficulties in determining compensation when third parties are negatively affected. A variety of methods exist to place a value on water. None are perfect. However, bargaining has been used to establish the intrinsic value of water and illustrates clearly that an in-source value can be established.

If water were given a more realisitic value, an incentive would be provided for more efficient use. In addition, the traditional approach of supply management could be complemented with demand management practices. In combination, these strategies could lead to a more rational allocation and use of water.

Economic efficiency is only one criterion deserving attention. However, if other criteria are to be used, society should be aware of the inefficiencies that are being accepted. Only in that way can reasonable trade-offs and compromises be reached.

## 1. Introduction

The concept that water as a commodity has value is not new. In 1966, the Royal Society of Canada designated water resources as the main theme for its annual meeting in Sherbrooke, Quebec. Dolman (1976, x) wrote that "Complacent attitudes about water resources cannot be justified anywhere today, for most parts of the world are either threatened by or are already suffering from inadequate reserves of clean fresh water . . ."

Despite this long-standing recognition of the value of water, North American society generally has not treated water as a valued commodity. Indeed, as Environment Canada (1983, 10) reported, "Traditionally, water has been considered a free good, and charges for its use have been related to the costs of treatment prior to use, distribution and pollution abatement. In contrast to most other natural resources, no commodity charge is attached to water itself".

To illustrate, consider some water consumption levels. An American study indicated that the average person in the United States uses 300 to 380 litres of water per day for drinking and in-home use (DeWane and Holthusen, 1982, S-3). Figures for Canadian consumption are similar. If a price per litre similar to gasoline (48¢/litre) were used to price water, the cost would be $145 to $180 for a one-day supply of water for *each* person in *each* household. These figures suggest that the real value of water is substantial, relative to a commodity such as gasoline which most of us rely upon every day. One wonders if we would have the "complacent attitude" towards water which was mentioned by Dolman if water were priced to reflect its actual value.

The consequences of undervaluing water as a commodity have been significant and deserve more attention. As Bocking (1972, ix) commented:

> ***The whole field of water development, long viewed as the embodiment of man's mastery over nature for the good of society, turned out to be largely a story of political manipulation of mind-boggling proportions. Amazing engineering work is frequently justified by a strange kind of economics that is remarkable for its lack of relationship to reality.***

Continuing, Bocking (1972, 89) observed that a person ". . . with even a modest understanding of modern economic thought must expect to feel something like Alice in Wonderland as he tries to find logical economic procedures underlying many of our great water projects of both past and future."

In this presentation, I would like to examine (1) the background against which to consider the value of water as a commodity, (2) the rationale for establishing a more realistic value for water, (3) alternative approaches for identifying a value for water, and (4) the general implications of an increased value for water management and development strategies.

Since the wisdom of hindsight is often more profound than the wisdom of foresight, to realize these four objectives I would ask you to join me in the year 2010, when a group of scholars are meeting as part of an ongoing review of the evolution of water management strategies. They already have held several such meetings, and at this one are focusing upong the major events and decisions of the 1970s and 1980s. We join them as they are reviewing the general background for water management in the 1970s and 1980s.

## 2. Context for Water Management in the 1970s and 1980s.

The scholars are surprised at several things. First, they are amazed at he number of obstacles frustrating attempts to improve water resource management. Second, they are intrigued that most of the obstacles have been identified and recognized, but that relatively little has been done to resolve them. For instance, they discovered a statement in a Canada-United States University Seminar (1973-11) addressng the management of the Great Lakes in which it was stated that:

> *There are a number of common factors that account for our inability to respond more effectively to the challenge to managing not only our water and land resources but other social problems as well. A listing of a few of the more significant factors affecting resource management include: the diffused public interest; differing views about national priorities; inadequate legislation and enforcement; special interest politics; fragmentation of responsibilities within and among governments; organizational jealousies; and lack of understanding of man-environment relationships.*

The scholars are intrigued at how complex and cumbersome water management has become by the early 1980s. The number of interrelated variables influencing water management decisions was large, emphasizing that it would be unrealistic to expect concentration upon a single factor to resolve problems. Even if water as a commodity were given greater value, they agreed that other aspects would need attention if improved management were to be realized.

A major dilemma for the scholars was the contradictory evidence they found regarding the time perspective used in water management. On one hand, they noted that, in Naisbitt's (1984, 81-101) *Megatrends*, one of ten basic patterns identified in the 1980s was that "we are restructuring from a society run by short-term considerations and rewards in favour of dealing with things in a much longer-term time frame" (Naisbitt, 1984, xxii). The scholars were impressed and encouraged by the suggestion of such a general trend in North American society. On the other hand, when they looked for evidence of such a trend in water management, they could find relatively little to verify its existence. They speculated as to whether the low value assigned to water contributed to the persistence of short-term thinking as well a reliance upon a relatively narrow range of strategies.

Despite the large number of issues deserving analysis, the scholars decided to concentrate upon the attitudes and approaches towards water as a commodity. As a start, they reviewed the prevailing ideas concerning the rationale for establishing a value for water.

## 3. Establishing a Value for Water

In reviewing the literature for the 1970s and the 1980s, the scholars identified two ideas which had been offered to support arguments that the value of water should be increased. The points were *efficiency* and *externalities*.

Regarding efficiency, Environment Canada (1983, 10) noted that economic principles indicate that when a good is undervalued, it tends to be overused. A most striking example of the implications of this for resource management was described by Hardin (1968, 1244) regarding the "tragedy of the commons". Hardin described a common pasture in Britain which became overgrazed as a result of each herdsman only considering himself and steadily adding more animals to the pasture. The end result was ruin for all as the common pasture became destroyed through overuse.

Tate (1984, 3-4) observed that policy makers have allowed water to be unpriced, or at least underpriced. With water pricing being in what he called an "irrational muddle", the implications are overuse. In Tate's (1984, 4) words:

> *In municipalities, average water use is artifically high. High system peaking is also experienced. Exaggerated demands will inevitably cause water systems to be overbuilt. This leads to an unnecessarily high burden on public treasuries. In the meantime, abundant (and cheap) water leads to artificially high demands, and the circle starts again.*

Experiences in several areas illustrate the effect of undervaluing water. Edmonton has metered all residential water users, and consumes half as much water as Calgary. Two pricing systems exist in Calgary for residences: a flat rate and a declining block rate based upon metering. The unmetered residences use 46 per cent more water than metered users (Thompson, 1983, 52). Furthermore, Gysi (1981) has calculated that, in Calgary, the savings due to metering were approximately 18,200 litres per month per household. Much of this saving resulted from the reduction of use in peak periods as a result of people being sensitive to the value of water when it is metered and charged for on the basis of actual use (Furst, Robinson and Benninger, 1981).

In Ontario, Gill and Leitch (1983) reviewed the water and sewer rates in the Regional Municipality of Durham. They documented that water pricing policies were designed to cover water system operations. In addition, a political decision had been taken to transfer a portion of water system revenues to general funds. This procedure helps to keep general taxes down by subsidizing other municipal services from the water revenues. However, from the viewpoint of encouraging efficient water use, this practice has disadvantages. As Gill and Leitch (1983, 212) remarked:

> *. . . the traditional approach to rate setting has resulted in improper price signals being sent to consumers. Rate design must translate actual water/sewer costs into prices. These prices . . . are signals sent to consumers . . . Only with proper pricing can consumers make economically efficient use of these resources.*

The "irrational muddle" regarding water pricing also applies to agricultural use. As Tate (1984, 4) explained:

> *In agriculture, massive subsidies lead to over-expansion of acreage, the growing of crops which could be best supplied more cheaply in other areas or by other areas, and ultimately to "demands" for more water, reallocation of water from perhaps higher-valued users and finally to agitation for water transfers.*

> *Irrigation is a tricky and potentially explosive topic to address in this manner in some parts of the country. "Regional development" is frequently put forth to meet this criticism. Yet . . . , we must recognize that the end product of agriculture is food, not irrigated land, and that perhaps we should do analyses aimed at the cheapest possible production, not at massively-funded irrigation schemes.*

To substantiate these arguments, Tate (1984, 3) indicated that irrigation throughout North America receives heavy subsidies. To illustrate, in Alberta, the government policy is to subsidize irrigation up to 75 to 85 per cent of the cost, and in the United States, irrigation subsidies often are higher (Bocking, 1972, 102, Howe and Easter, 1971, 168-171). For example, MacGregor (1982, S 20) reported that irrigators utilizing water from U.S. Water and Power Resources Service projects pay from $35 to $135 less per acre per year than it cost, or pennies per thousand gallons". It was on this type of evidence that Armitage (1983, S 18) concluded that, in the United States, "politics and not economics has been the driving force behind national water policy. In the west, federal reclamation policy gave federal subsidies to develop agriculture and promote settlement."

Tate, Reynolds and Dossett (1984, 3) highlighted some of the problems that emerge from undervaluing water as a commodity. Their comments apply to Canada, but the remarks have validity when applied to the United States as well. In their words:

> *. . . it is apparent that water pricing . . . has failed to act as an incentive for water conservation or as a means of encouraging socially optimal levels of supply. Rather, water use has traditionally been viewed as cost-free, with charges being levied to recover system construction and operating costs. The result has often been the over-building of systems, waste of public funds and sub-optimal water use practices.*

The second concept which the scholars identified was that of externalities. In the jargon of economists, "an externality occurs when the action of an individual or group of individuals has economic consequences which are not priced by the market" (Hartman and Seastone, 1970, 2). In addition to illustrating inefficiency, Hardin's story about the "tragedy of the commons" also is an example regarding externalities. In other words, each herdsman did not consider the consequences for others from his decision to add extra animals to graze upon the commons. As long as there was gain for himself, the individual herdsman was not concerned about the consequences for the larger group. And, as we saw, eventually the entire commons was destroyed.

Similar issues and concerns may arise when water resources are undervalued. Thus, an area which is facing shortages of water may look to areas of water surplus as sources of supply. However, while the receiving area will realize many direct and indirect benefits from the transfer of water, the source area and the area through which the water is transferred may experience most of the direct and indirect costs. When water is undervalued or not given any inherent value, there is difficulty in realizing equitable compensation for the areas incurring the costs. In contrast, designation of a value for water provides a mechanism for financial compensation or for some comparable compensation in kind.

The scholars concluded from their examination of prevailing ideas in the 1970s and 1980s that at least some individuals were well aware of the serious problems being created through conscious decisions to undervalue water. In brief, the two major problems were inefficient use of water and negative impacts for third parties. It seemed to them that many of those problems could be at least partially resolved if a higher value was given to water. For that to occur, however, a method to value water was required. As a result, they decided to examine the alternative ways which were used or which might have been used to price water.

## 4. Approaches to Placing a Value on Water

The scholars noted that pricing water to give it a value was perceived to be fraught with problems. As Armitage (1983, S-18) had remarked:

> *Placing a value on water is hardly an easy task. All life forms depend upon it. Putting a dollar figure on the value of ensuring an adequate and safe supply of water raises ethical and political questions . . . For better and for worse, water programs developed for reasons far removed from economic efficiency.*

For such reasons, water usually has been treated as a free good (DeWane and Holthusen, 1982, S-4; Schroeder, 1983, S-5; Tate, 1984, 3). As a result, the value of water has been determined with reference to the costs of pumping, treatment and distribution. The water itself, unlike oil, minerals, fish, timber or other resources, was given no intrinsic value. Indeed, as illustrated previously by the significant subsidies given to agricultural water users, consumers often have not even paid the full cost of delivering water to them. Some consequences of this approach have been inefficient use, over-building of supply systems, and subsidies from some sectors in society to other sectors.

Although no perfect mechanism was available for establishing a value for water, the scholars discovered that several alternatives had been identified. The first procedure involved assigning value with regard to the cost of the "next best alternative". This approach would reflect the cost of obtaining and delivering alternative supplies

(DeWane and Holthusen, 1982, S-11). Environment Canada (1983, 10) has illustrated how this procedure could be applied to hydro-electric production for which water is a primary output. If Canada's hydro-electric production in 1980 had had to be produced in oil-fired plants, the expense incurred for fuel alone would have ranged between $9 billion and $12 billion, depending upon whether domestic or world oil prices were utilized. Calculating the value of non-withdrawal uses (boating, fishing) presents numerous difficulties, but ball-park figures can be generated for them as well.

The second procedure established value with reference to the value added to the consumer's products or satisfaction. Using agriculture as an example, the difference in value of agricultural output with and without irrigation in an area could be calculated. Recreation also could be handled in this way. Environment Canada (1983, 10) reported that data showed that, during 1981, Canada had $210 billion in family income. About 7 per cent of that was spent on recreation, and about 75 per cent of recreation was water-oriented. On that basis, $11 billion would have been spent on water-oriented recreation in 1980. This procedure has a major flaw in that the derived figures reflect the costs of all factors of production or satisfaction. As a result, the value of water is over-stated. Nevertheless, both "value added" and "next best alternative" approaches help to emphasize the substantial value of water as a commodity. The actual figures will always be open to debate, but the relative magnitude of the value is suggested and could be used for discussing compensation when negative externalities arise.

A third procedure would involve assigning an explicit value to water before it is developed, as is done with oil, timber and other resources. The cost to the user would then reflect the intrinsic value of water plus the cost of pumping, treating and distributing. Economists do not have any magic formula to establish the in-source value of water, but a time-honoured procedure is available: bargaining between or among interested parties.

Schroeder (1983, S-3) has reminded us that, using this procedure, South Dakota "has put a price on water *at the source*—a previously unheard-of precedent . . ." The agreement to which Schroeder referred was with a private corporation to provide 1.98 cubic metres per second (70 cubic feet per second or 50,000 acre-feet) of water per year of Missouri River water. In return for $1.4 billion in payment over a 50-year agreement, water from the Missouri River in South Dakota would be available to be piped to Wyoming, a distance of 445 kilometres, where it would be mixed with pulverized coal to make a slurry. The coal slurry would then be piped 2,660 kilometres to markets in Oklahoma, Arkansas and Louisiana (Morrisette, 1983, S-29).

How was the value of water established? South Dakota noted that six reservoirs had been built on the mainstem of the Missouri River, four of which are located in South Dakota. The dams were multiple purpose in design, serving navigation, flood control, irrigation, hydro-power, industrial and recreational development. Most of these benefits were received by downstream states, even though South Dakota gave up 214,500 hectares of farmland when the reservoirs were created. As the Director of the Department of Water and Natural Resources in South Dakota observed:

> *The question arises from South Dakota's standpoint: Who is benefitting from the construction of these reservoirs?. . .*
>
> *While the loss at 530,000 acres (214,500 hectares) of land in South Dakota is providing substantial navigation, flood control and power benefits for our neighbouring states, South Dakota is receiving little or no benefit in a substantial economic sense from the construction of the reservoirs (Smith, no date).*

The bargaining for the water began when Energy Transportation Systems Inc. (ETSI) recognized that if coal could be transported in a slurry form, the firm would realize substantial savings. The reason centered upon the capital-intensive nature of coal slurry pipelines relative to railroad transportation. ETSI calculated that 70 per cent of the operating costs for a coal slurry pipeline are fixed, leaving only 30 per cent as variable and therefore subject to inflation. In contrast, ETSI estimated that 85 per cent of the operating costs for railroads are variable and subject to inflation. During a period of inflation, the form of transportation with the highest ratio of fixed costs has a competitive advantage. ETSI's calculations showed that, with only a 5 per cent rate of inflation, the cumulative savings in operating costs by using the coal slurry over a 30-year period would be $32 billion (Smith, no date).

Against this background, the bargaining began between South Dakota and ETSI, and carried on over a period of four or five years. Neufeld (1982, 127) described the bargaining process in the following manner:

> *All I can say about the economics of interbasin transfer with respect to ETSI is that we sat down at the bargaining table with those people and we had certain economic and political cards in our hands, and they had certain economic and political cards in their hands. Every time they made an offer, we just kept saying "no" until we were afraid that they were going to walk away from the table, and then we said "yes". It was just a very straight business deal, with each side holding certain advantages over the other.*

The end result was that ETSI obtained a 50-year agreement for a supply of water, and South Dakota will receive indexed payments which could total $1.4 billion over the life of the contract.

Thus, the group of scholars concluded that, by the early 1980s, society had a number of procedures to place a value on water: (1) next best alternative, (2) value added, (3) intrinsic or in-source value. None of these procedures was perfect, but each moved water away from being handled as a "free" good with the associated problems of inefficiency and negative externalities. With this in mind, the experts considered the implications of water as a "free" good or as a valued commodity for water management and development strategies.

## 5. Implications For Water Management and Development

The scholars concluded that, by the early 1980s, ample evidence was available to document the numerous problems which were partially attributable to water being undervalued. Society was often wasteful in its use of water, usually because there was little incentive to improve efficiency. It was this situation which led DenUyl and Nickel (1982, 14) to conclude that scope existed for substantial improvement in the efficiency of irrigation systems, especially in the American west. Indeed, they remarked that "conservation of water, both in agriculture and other uses, has been set back by the relatively low subsidized prices paid in the west." As a result, they suggested that it ". . . was highly unlikely that an interbasin transfer of water from the Great Lakes for the purpose of supplying irrigation water to the west could be justified by any economic criteria."

The scholars also concluded that, by the 1980s, there was a good understanding of the negative externalities associated with the undervaluing of water. Thus, while the importing area could receive many benefits from a water diversion, the exporting area could experience many costs. Using the Great Lakes as an example, changes in lake levels as a result of diversions could affect hydro-power generation, navigation and coastal zone interests (erosion and inundation effects on shore property) (DeCooke et al, 1983, 11-12). If those groups and interests were to be compensated for negative impacts, a realistic appraisal of the value of water had to be established. Establishing such a value would not eliminate the externalities, but it would facilitate compensation.

Undervaluing water also contributed to a pre-occupation with structural or technological manipulation of supply systems, rather than combining a mix of strategies to manage demand and supply. Demand management focuses upon reducing the quantities of water required by society through rational water pricing, irrigation canal lining, promotion of industrial water recirculation, retrofitting existing water-using fixtures and public education (Tate and

Reynolds, 1983, 18). However, as Lang (1983, S-6) remarked, "There are no publicized ribbon-cutting ceremonies for fixing pipes, roofs, wiring and plumbing." In contrast, "large-scale diversion projects remain politically fashionable." (Thomas, 1983, S-10).

Nevertheless, the scholars were puzzled that, by the 1980s, water managers had not learned more from the "energy crisis" of the 1970s. Shortfalls of energy supplies in the mid 1970s led to an increase in prices and to introduction of conservation measures. The result was a drop in demand by the early 1980s and, in some instances, the creation of surpluses. While the demand for water is not as elastic or price-sensitive as it is for energy, decreased use of water could be expected if more realistic pricing were introduced with other demand management strategies (Tate, 1984, 6).

The scholars agreed that, too often, conservation and development are wrongly perceived to be in opposition to one another. In that regard, they supported the arguments of the International Union for Conservation of Nature and Natural Resources (1980) that the goal should be to use conservation to support long-term sustainable development. In that sense, demand and supply management become complementary tools. If water resources are depleted, then Hardin's "tragedy of the commons" will be repeated, and there will not a resource to develop and manipulate.

The scholars concluded that, in the 1970s and 1980s, North American society had consciously created water management strategies that led to wasteful and inefficient use of water. However, those experts recognized that economic efficiency is only one criterion to consider in judging alternatives. Society might well decide to emphasize other aspects, such as to promote certain kinds of activity, or to benefit certain groups in preference to others, or to favour certain areas (Campbell, Pearse, Scott and Uzelac, 1974, 477). These are all legitimate objectives, but the scholars concluded that, in pursuing them, governments should be aware of the economic efficiency costs being incurred, especially when third parties receive negative impacts.

Castle (1983) has confirmed that objectives other than economic efficiency have dominated water management. His comments refer to the United States, but they also are applicable to Canada. In his view:

> *Historically, many major water development projects in the United States were undertaken to provide economic opportunity and to develop particular geographic areas. Water development became a way of transferring income or wealth from group to group and region to region, and efficient or economical use of water rarely was a central issue of water development policy (Castle, 1983, 59).*

Related to that conclusion, he also concluded that:

> *. . . research makes clear . . . that water often becomes a convenient political tool for doing something for one's constitutents. In a political sense, it really is income rather than water that is being transferred (castle, 1983, 63).*

If we are to understand the nature of such income redistributions and the potential trade-offs or compromises, it is essential that we have a better understanding of the actual value of water as a commodity. Whatever society identifies as overall objectives, it is not realistic to continue treating water as a free good.

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# Impacts of Great Lakes Water Supply Modification

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## Abstract

As water shortages occur in portions of the western United States, it is anticipated that interest will grow in the possibilities of diverting Great Lakes water. The paper outlines the existing institutional arrangements which must be considered in the decision process, and existing Great Lakes diversions are reviewed and their impact on mean lake levels are presented, along with options available for greater stabilization of the system. Consumptive uses are evaluated in light of their projected growth. For the purpose of this paper, two potential diversions to provide water for trans-basin diversion are evaluated. The economic effect of these potential diversions on Great Lakes water users and the costs of the projected increase in consumptive uses are presented as an example of this problem's magnitude. In this preliminary evaluation, the legal problems and environmental impacts have not been included, which would add to the project cost.

## Introduction

The Great Lakes are an international resource and, as such, an international responsibility. No other body of fresh water in the world is so important to the lifestyle and standard of living of so many people. In the United States, the Great Lakes basin (Figure 1) contains one-seventh of the total U.S. population, and produces one-sixth of the national income. In Canada, these figures are even more dramatic, with about one-third of the Canadian population living in the region and producing nearly one-half of its national income.

Part of the reason the area is so heavily industrialized is the efficient and economical transportation offered by the lakes and the availability of inexpensive power. The lakes also offer an extensive recreational area for use by its residents and is an attraction to others from throughout both countries. As such, each of these interests, at time, is adversely affected by the fluctuating levels. When this occurs, outcries are heard for greater management of those elements affecting the water supplies to the system and for controls on the use of Great Lakes waters.

To manage the resource and to explore the options available, one must have knowledge of why the levels change and the effect these changes have on the current users of the system. These effects have been documented on numerous occasions and reported on by Canadian and United States Government agencies. Internationally, reports reflecting impacts of water supply modifications have been prepared under the auspices of the International Joint Commission. These studies indicate that the major changes in the system are caused by natural factors. However, man has also caused impacts. Since management can only be related to control of the artificial factors, this paper will only briefly touch on the natural factors, and will concentrate on a discussion of the impacts of modification of the artificial water supply factors, what options are available for greater stabilization of the system and the existing institutional arrangements which must be considered in the decision process.

## Natural Factors Affecting Fluctuations

The levels of the Great Lakes are never constant. Short-term variations are caused by winds and pressure changes, whereas long-term water level variations are caused by changes in lake water volume. The change in lake volume is a result of an integration of all the hydrologic factors (Figure 2) (precipitation, evaporation, runoff and groundwater) which affect the land and lake surfaces of the basin, as well as the hydraulic characteristics of the connecting channels and the St. Lawrence River (Figure 3). The magnitude of these variations is as follows:

| Lake | Mean Annual Range in Feet | Total Range in Feet |
|---|---:|---:|
| Superior | 1.1 | 1.1 |
| Michigan-Huron | 1.1 | 6.6 |
| Erie | 1.5 | 5.3 |
| Ontario | 1.9 | 6.6 |

The seasonal variation and annual range of the lakes are a direct reflection of the yearly climate. In the winter, the water supply to the system is generally in the form of snow, which is locked on the basin. In the spring, this snow melts and, combined with rainfall, causes the lakes to rise to a peak in late spring or early summer. During the summer and early fall months, evaporation increases and precipitation decreases, causing the lakes to fall from the peak until they reach their winter lows.

The long-term variations in lake levels are caused by periods (more than one year) of persistent high or low precipitation and evaporation. The lengths of such periods and intervals between them are variable and non-predictable. An example of the yearly and long-term cycles are shown on Figure 4. Man has little or no control over these natural factors.

## Artificial Factors Affecting Fluctuation

From our knowledge of hydrology, it is logical that man's acitivities of clearing, draining, irrigating and urbanizing have changed the hydrologic characteristics of the land area supplying water to the Great Lakes. Although local hydrologic problems have resulted from these activities, most of these changes have taken place gradually over the last 150 years. Hence, it is difficult to quantify the impact of these activities. However, the effect of man's activities on the levels of the Great Lakes in relationship to dredging, diversions, consumptive uses of water and regulation can be quantified. In all cases, except for regulation, the full impact of these factors is felt over the entire range of stage.

### *Dredging*

From the initial use of the Great Lakes system as a water route for settlers, changes have been made to provide improved channels for navigation. Dredging of the St. Marys and St. Lawrence Rivers has also been accomplished as an integral part of the regulation of Lakes Superior and Ontario. These channel improvements have permitted an expanded range of discharges for given lake levels under regulation, as well as providing for 27-foot navigation throughout the system. It has been estimated that these changes, including commercial gravel dredging in the St. Clair River, have lowered the mean levels of Lakes Michigan-Huron by 0.4 to 0.6 feet. This work has had a transitory effect on the Lake Erie level. The impacts on Lakes Superior and Ontario have also been modified through the regulation of those lakes.

### *Diversions*

Currently, there are five significant diversions of water into, out of or within the Great Lakes system; two increase the water supply, one decreases the water supply, one by-passes the natural outlet river, and one has little or no effect on the system. These diversions are the Long Lake and Ogoki Diversions (Figure 5), which divert water from the Hudson Bay drainage basin into Lake Superior at an average annual rate of 5,600 cfs; the diversion of water out of Lake Michigan at Chicago (Figure 6) at an average annual rate of 3,200 cfs; the Welland Canal Diversion out of Lake Erie, which by-passes the Niagara River at a current average annual rate of 9,200 cfs; and lastly, the New York State Barge Canal Diversion, which takes water out of the Niagara River and returns it to Lake Ontario. The later diversion averages about 700 cfs annually. The effects of these diversions at their present rates are shown on Table 1.

A review of the history of these diversions indicates that their rates have varied over the years and they can be altered by man to affect the Great Lakes regime of levels. In the case of the Long Lake and Ogoki Diversions, which have diverted water into the system since 1940 and 1943, one or both of these diversions has been reduced or shut down on 20 occasions. Studies have also been made to determine if, during periods of low water supply to the system, additional water could be obtained through this source. These studies show that the meteorlogical conditions of the Albany River watershed are similar to those of the Great Lakes; hence, it is not possible to increase the flow through this system during periods of low water supply on the Great Lakes. These studies also show that, due to physical restrictions within channels draining into the Great Lakes system from Lake Nipigon and Long Lake, it is not possible to bring substantially more water into the Great Lakes system over and above that which currently exists. Therefore, the Albany system cannot be used to offset greater diversions, on a continuing basis, from the Great Lakes system. The impact of shutting off the diversion during periods of high supply to the Great Lakes is shown on Table 2.

A review of the historic records of the Chicago Diversion indicates that annual rates of up to 10,000 cfs had been discharged through the system. Moreover, during periods of low local inflows, the physical capacity of the system would permit maximum average daily discharges as high as 12,000 cfs. However, because of constraints on the system related to downstream flooding, only 8,700 cfs could be discharged on an average annual basis. During periods of low supply on the Great Lakes, it is not practical to reduce this diversion from its present rate of 3,200 cfs because most of the water diverted is used for domestic and sanitary purposes. The impact of varying the diversions between the indicated amounts is shown on Table 2.

As noted earlier, the New York State Barge Canal draws water from the Niagara River and discharges into Lake Ontario. This canal cannot be used to modify the levels of the Great Lakes system due to its withdrawal location (downstream) in relation to natural hydraulic control sections of the Niagara River.

### *Consumptive Uses*

Most of the water withdrawn from the Great Lakes system for human use is eventually returned to the system by direct discharge into lakes and streams or by infiltration. The portion of the water not returned to its source is categorized under the term "Consumptive Use". This includes water which is assimilated by animals, humans and plants, incorporated into products during industrial processes or lost from the system through evaporation or leakage during use. It has been estimated by the International Great Lakes Diversions and Consumptive Uses Study Board that the combined U.S. and Canadian water consumption in 1975 was 4,900 cfs. They further estimate that, by the year 2035, this figure may grow to 16,300 cfs, and could be as high as 36,500 cfs. The growth associated with this increased water use is expected to be focused in southern Lake Michigan, Lake Erie and western Lake Ontario. The relative consumption by water use sectors in the Great Lakes Basin in 1975 and 2035 are shown on Figure 9. If this projection becomes a reality, we can expect the level of Lake Superior to be on the average 0.3 feet lower, Michigan-Huron 0.7 feet lower, Lake Erie 0.8 feet lower, and the average outflow from Lake Ontario through the St. Lawrence River reduced by about 9 per cent. Such a reduction in levels and flows will result in an average annual loss to navigation in excess of $14.0 million; to power in excess of $150 million; while providing benefits to shore property interests in excess of $6 million.

### *Regulation*

Natural regulation exists on Lakes Michigan-Huron and Erie, while artificial control of the outflows exists on Lake Superior and Ontario. This artificial control began on Lake Superior in early 1920 and on Lake Ontario in 1960. The object of regulation of these two lakes is to maintain the levels within given specified limits while satisfying given restrictions on flow releases. Regulation of Lake Ontario only affects that lake, while the regulation of Lake Superior impacts throughout the system. The regulation of Lake Superior has raised its mean level by about 0.3 feet, compressed its range 0.8 feet and compressed the ranges of all lakes downstream of Lake Superior (Lake Michigan-Huron 0.4 feet, Lake Erie 0.3 feet, and Lake Ontario 0.3 feet). The regulation of Lake Ontario has not affected its mean level, but compressed its range by 1.25 feet.

## Further Demands on The System

The study on Global Resources commissioned by President Carter identified an adequate supply of fresh water to be a major world problem by the year 2010. In many areas, one means which is often cited as a possible solution for local water shortage is trans-basin diversion. In fact, there are many examples of such diversion in the United States, Canada and elsewhere throughout the world, where major diversions have been implemented in order to alleviate water shortages. As water shortages become more severe in the United States and possibly Canada, it may be expected that there will be increasing interest in tapping the Great Lakes to assist in solving such problems. Prior to instituting such diversions, one must carefully examine the economic and environmental impacts upon the basin/drainage areas providing the water, as well as the economic and environmental impacts which are expected to be realized by the gaining region.

The previous section of this paper outlined the current impact of man on the system. In addition, there was a short discussion of possible impacts of projected increased consumptive uses. As indicated, man's impact has, in general, lowered the levels of the systems. This lowering has resulted in benefits to shore property interests, and disbenefits to navigation and power interests. Any further diversions from the system would compound these impacts. For example, if 10,000 cfs were diverted from Lake Superior, every lake in the system would feel the impact by the lowering of the mean level of:

| | |
|---|---|
| Lake Superior | .50 feet |
| Lake Michigan-Huron | .66 feet |
| Lake Erie | .46 feet |
| Lake Ontario | .54 feet |

If that same 10,000 cfs were withdrawn from Lake Erie, the lowering of the mean level would be:

| | |
|---|---|
| Lake Superior | 0.07 feet |
| Lake Michigan-Huron | 0.18 feet |
| Lake Erie | 0.48 feet |
| Lake Ontario | 0.49 feet |

The economic impact of such a diversion would be a net average annual loss to the users of the system of $87.0 million ( + $11.0 million Shore Property; –$20.0 million Navigation; and –$78 million Power) if the diversion was from Lake Superior, and $75.0 million if the diversion was from Lake Erie ( + $8.0 million Shore Property; –$60 million Navigation; and –$76.0 million Power).

This illustration demonstrates that, to minimize the impacts on the users of the Great Lakes system, extraction of water would best be made from the lower lakes. This impact can be further minimized by changes in the method of regulation or in the criteria for regulation of Lakes Superior and Ontario, or the interjection of water into the system from outside the basin.

Utilization of modified regulation schemes is a non-solution since the loss of water would be the same. Regulation could accommodate the loss in relation to levels, but impacts would be felt on flows; or the flows could be held constant, with impacts being felt on the levels. A change in the criteria for regulation to provide for greater storage (range in levels) of water during high water periods could be used to offset withdrawals. However, this would result in a disbenefit to shore property interests.

To date, only a few studies have been made at the Federal Government level to evaluate the potential of interjection of water into the system. One, the I.J.C.'s Diversions and Consumptive Uses Study, which was referred to earlier, studied the possibility of increasing the inflow from the Albany River Basin into Lake Superior during periods of below normal level. As reported, the results of the study indicated that, during low water supply periods on the Great Lakes, climatic conditions on the Albany Basin are similar to those of the Great Lakes. Hence, no water was available for input into the Great Lakes. Interjection of water during high supply periods is restricted because of the physical capacity of channels connecting the Long Lake-Ogoki Systems with Lake Superior.

The federal/provincial studies carried out by Canada in the early 1970s indicated that a potential exists for diversion of Canadian water to the lakes. However, in that study, no extensive climatic studies were undertaken as part of the effort. This aspect still needs to be evaluated to determine the availability of water at critical times as well as the environmental impact on those areas of diversion. The cost of implementing such diversion would be very high (ranging from $1,400 to $12,900/cfs—1968 price index).

It should also be noted that climatic conditions are not predictable for any extended period. Continual interjection of water to offset a withdrawal may result in damage to users of the Great Lakes system. Studies made by both Government's indicate that artificial changes in the Great Lakes' natural water supply can be felt in the system for over 15 years. Hence, water interjected into the system during a period of normal level could cause the residue/damage effect during a high level period.

## Institutional Arrangements

The use, regulation and preservation of the water in the Great Lakes basin is accomplished by a complex system of international treaties, local, state, provincial and Federal court decisions, and local, state, provincial and Federal Statutes, administrative policies and programs. With reference to the existing major diversions within the Great Lakes system, they were authorized through an exchange of notes between the U.S. and Canadian Governments in the case of the Long Lake—Ogoki Diversion; between the State of Illinois and U.S. Supreme Court in the case of the diversion out of Lake Michigan at Chicago; through an agreement between the Canadian Crown Corporation, St. Lawrence Seaway Authority and Ontario Hydro in the case of the Welland Canal Diversion; and by the State of New York who owns and operates the New York State Barge Canal System.

The International Joint Commission, under the 1909 Treaty mandate, has not exercised control over the water usage of any of these diversions. To deal with this matter in the future, it is the view of the author of this paper that new and/or revised institutional arrangements must be put in place. In establishing these arrangements, the authorizing body should have the ability to:

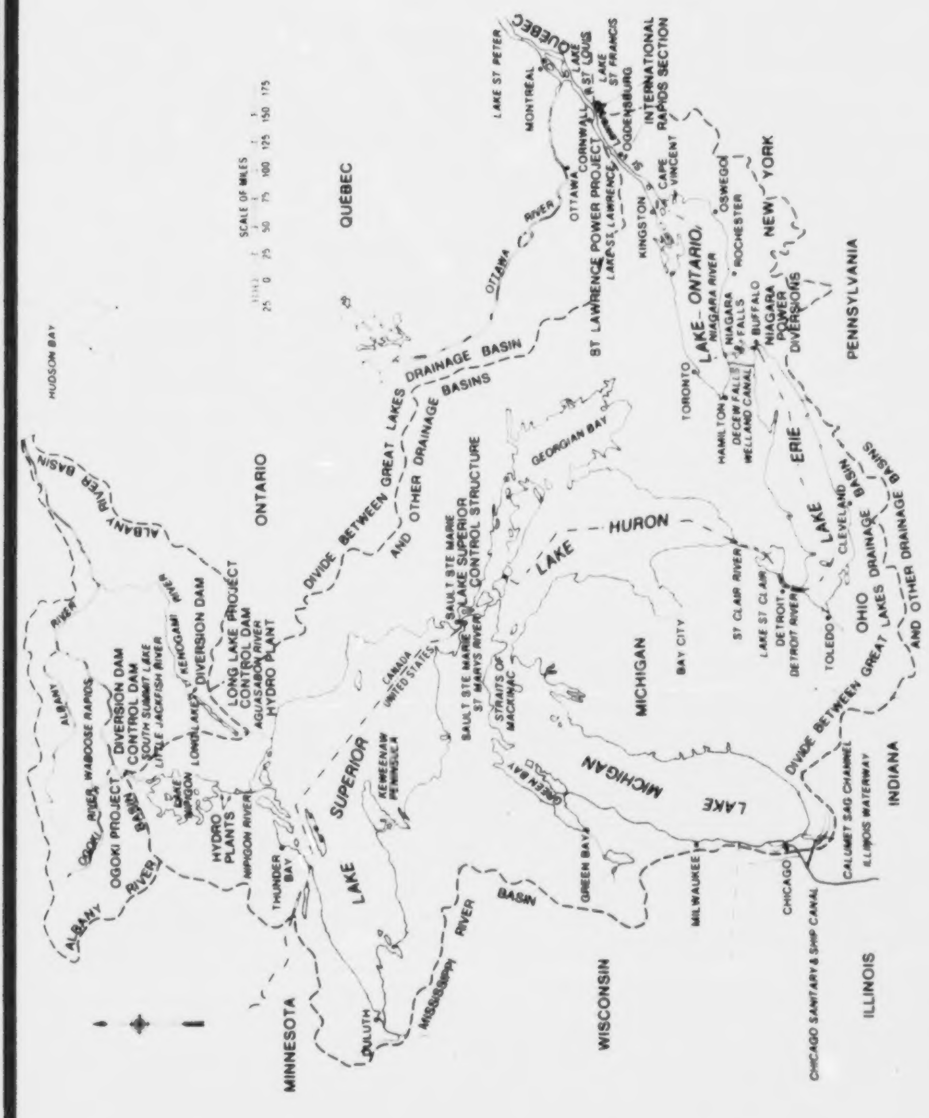
(a) carry out international investigations, monitoring and surveillance,
(b) have the mechanism, resources and purpose to deal with nation-wide, basin-wide, multiple-use resources,
(c) have the authority to set priorities for water use within agreed-upon international or national policies, goals and objections.

## Summary

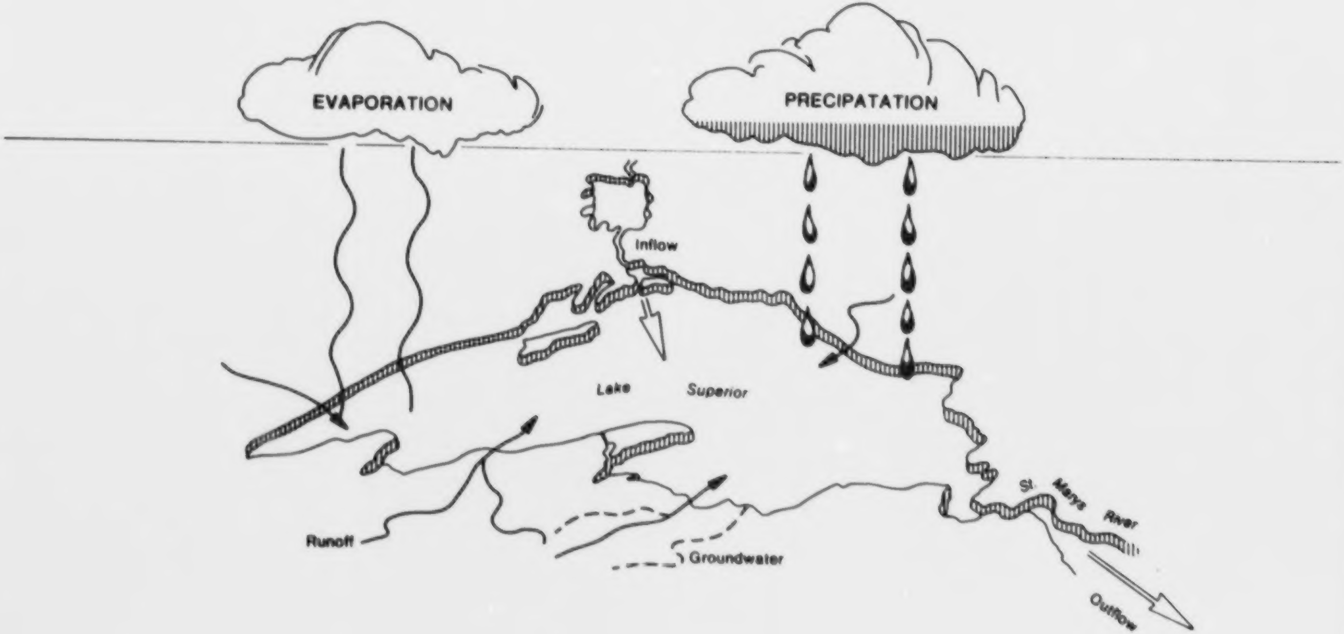
The water levels of the Great Lakes are affected by both natural and artificial factors. The effect of the artificial factors on the Great Lakes levels and flows are small in comparison to the natural factors. The artificial factors which receive the greatest attention during periods of extreme levels on the system are the diversions into, out of and within the system. The net effect of the existing diversions is less than 0.1 feet on all lakes except Lake Erie (0.3 feet). Consumptive use of water within the system, which currently is at approximately the same magnitude as the Long Lake—Ogoki Diversion, is expected to grow by a factor of five over the next 50 years. If the growth occurs, very large economic losses will result to navigation and power, with benefits of a lesser magnitude occuring to shore property interests.

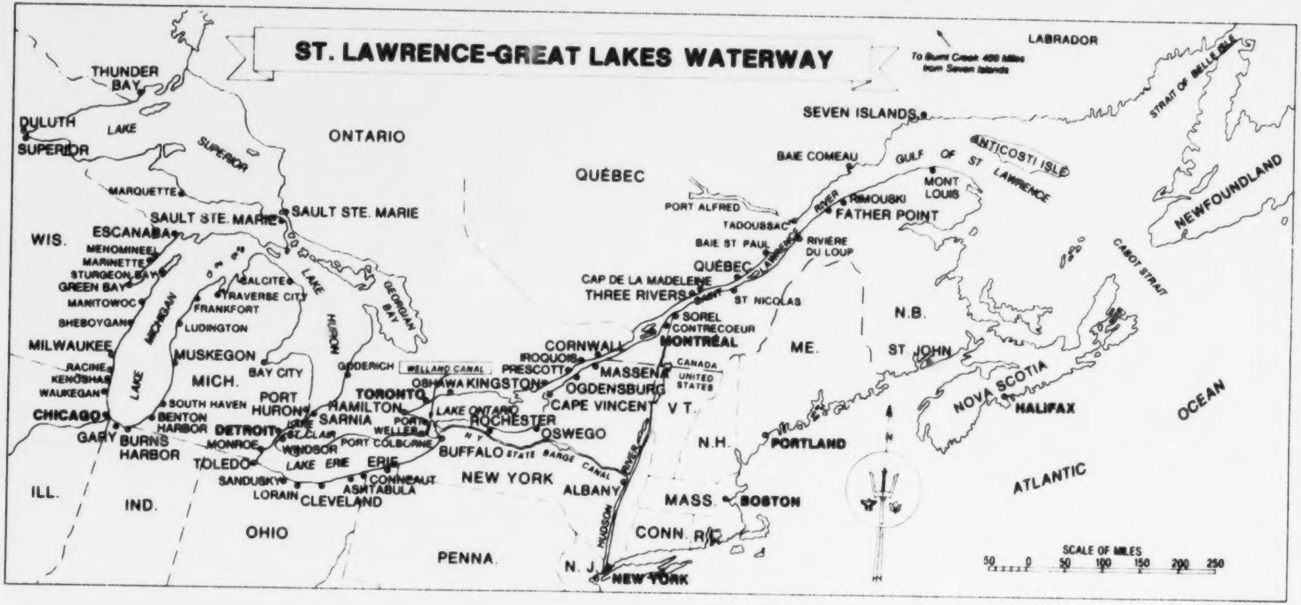
The use of the Great Lakes to provide water to other parts of the country will cause large economic disbenefits to the users of the Great Lakes, averaging annually from $75 to $87 million (based on a 10,000 cfs withdrawal from the system). To provide make-up water to the Great Lakes from Canada does not appear practical, since climatic conditions in the adjacent areas are similar to those of the Great Lakes, and would be very costly. To provide water to the Great Lakes system during a plentiful water supply period in the adjacent areas may result in disbenefits because of the time lag in the Great Lakes system.

Institutionally (nationally and internationally), a mechanism needs to be put in place to develop governing consumptive use criteria, and firm policies developed to deal with transfer of water between basins.

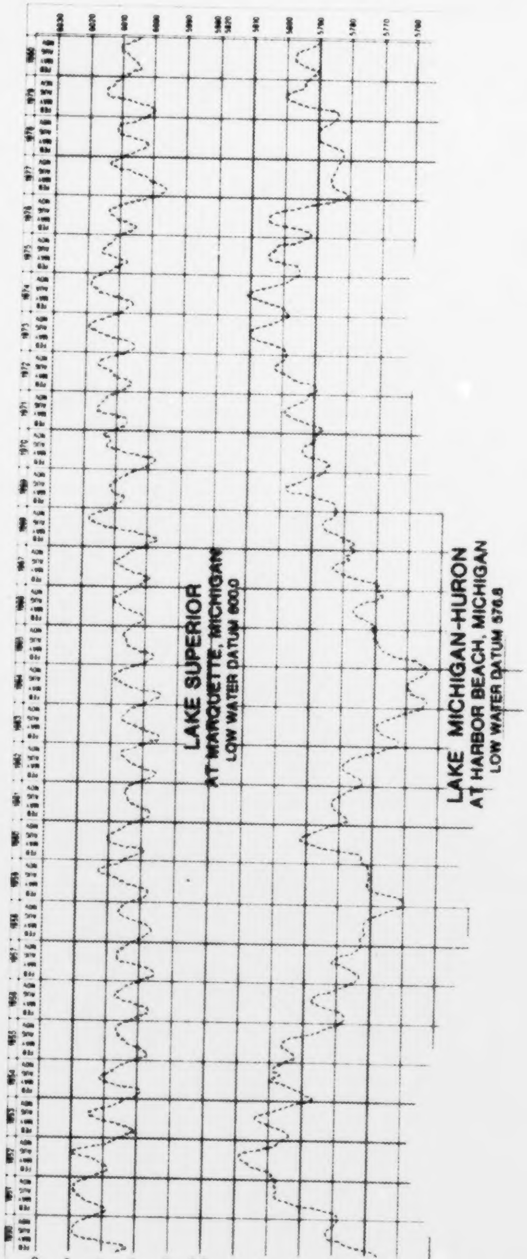

HUDSON BAY
SCALE OF MILES
25 0 25 50 75 100 125 150 175
QUEBEC
ONTARIO
ALBANY RIVER BASIN
ALBANY RIVER
OGOKI RIVER
WABOOSE RAPIDS
OGOKI PROJECT
DIVERSION DAM
CONTROL DAM
SOUTH SUMMIT LAKE
LITTLE JACKFISH RIVER
KENOGAMI RIVER
DIVERSION DAM
LONG LAKE
LONG LAKE PROJECT
CONTROL DAM
AGUASABON RIVER
HYDRO PLANT
LAKE NIPIGON
NIPIGON RIVER
HYDRO PLANTS
THUNDER BAY
LAKE SUPERIOR
KEWEENAW PENINSULA
DULUTH
MINNESOTA
MISSISSIPPI RIVER BASIN
WISCONSIN
GREEN BAY
MILWAUKEE
CHICAGO
CHICAGO SANITARY & SHIP CANAL
CALUMET SAG CHANNEL
ILLINOIS WATERWAY
ILLINOIS
INDIANA
LAKE MICHIGAN
MICHIGAN
BAY CITY
STRAITS OF MACKINAC
SAULT STE MARIE
ST MARYS RIVER
CANADA
UNITED STATES
SAULT STE MARIE
LAKE SUPERIOR CONTROL STRUCTURE
DIVIDE BETWEEN GREAT LAKES DRAINAGE BASIN AND OTHER DRAINAGE BASINS
GEORGIAN BAY
LAKE HURON
ST CLAIR RIVER
LAKE ST CLAIR
DETROIT
DETROIT RIVER
TOLEDO
CLEVELAND
LAKE ERIE
OHIO
DIVIDE BETWEEN GREAT LAKES DRAINAGE BASINS AND OTHER DRAINAGE BASINS
PENNSYLVANIA
HAMILTON
DECEW FALLS
WELLAND CANAL
TORONTO
NIAGARA RIVER
NIAGARA FALLS
BUFFALO
NIAGARA POWER DIVERSIONS
LAKE ONTARIO
ROCHESTER
OSWEGO
NEW YORK
KINGSTON
CAPE VINCENT
LAKE ST LAWRENCE
ST LAWRENCE POWER PROJECT
OGDENSBURG
INTERNATIONAL RAPIDS SECTION
CORNWALL
LAKE ST FRANCIS
LAKE ST LOUIS
OTTAWA
OTTAWA RIVER
MONTREAL
LAKE ST PETER
QUEBEC

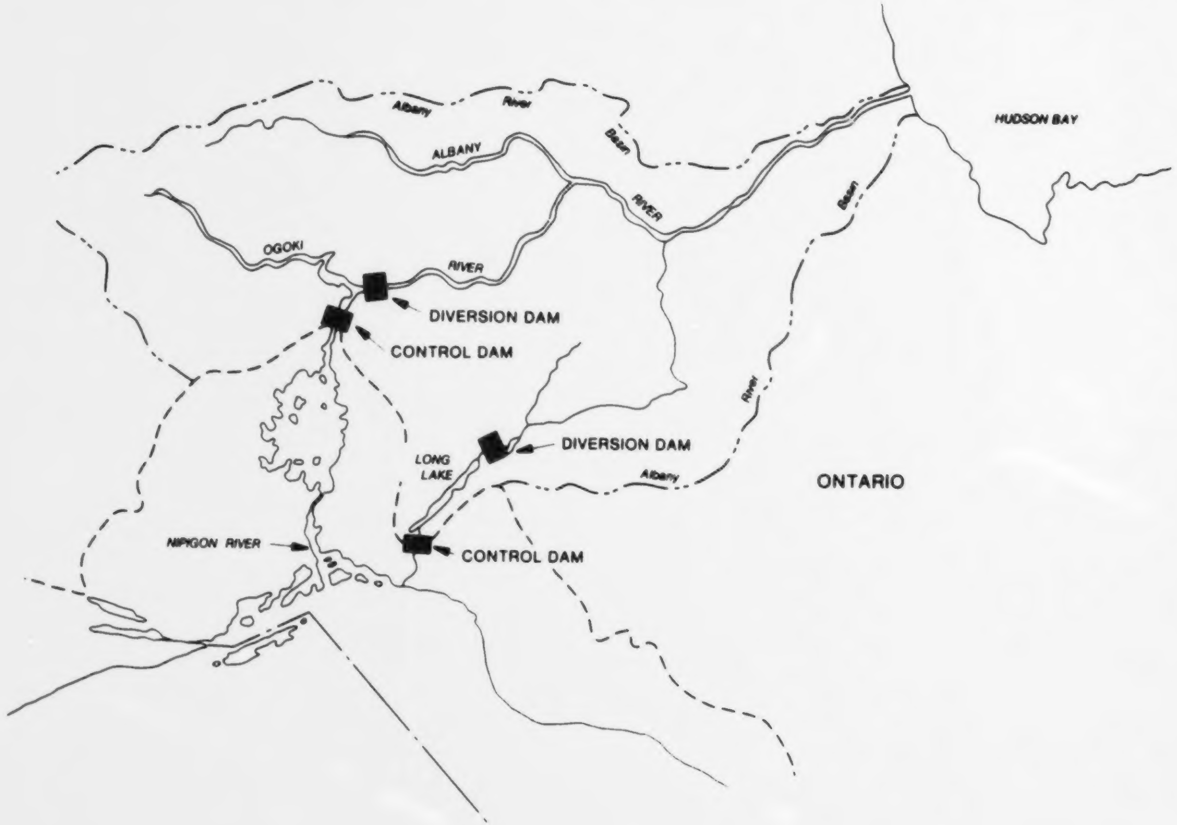
## Natural Factors Affecting the Levels of the Great Lakes

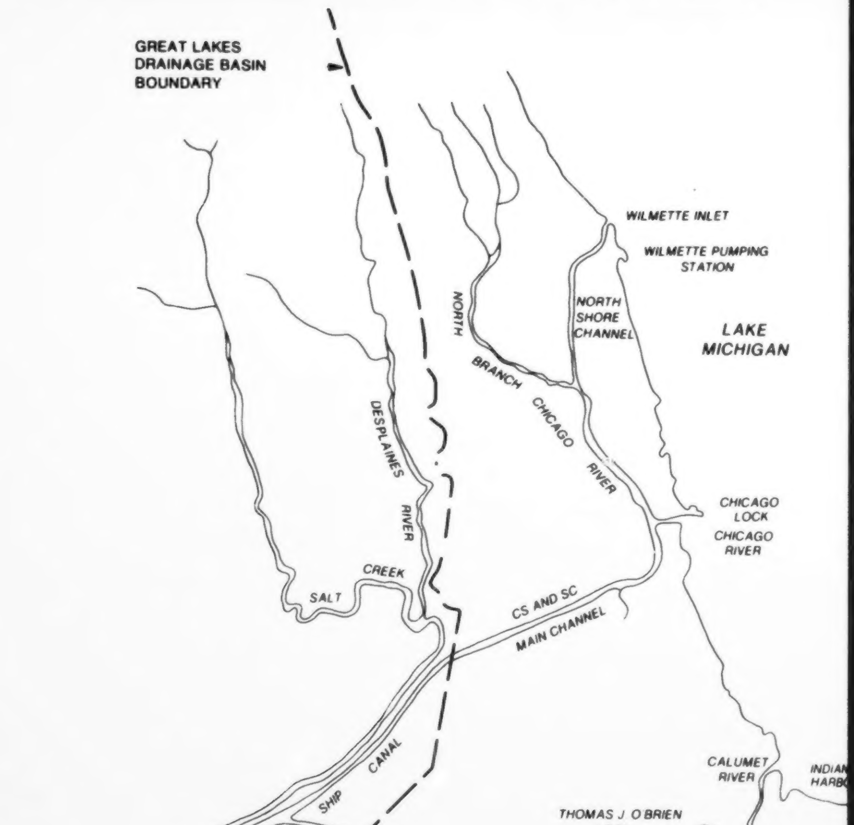




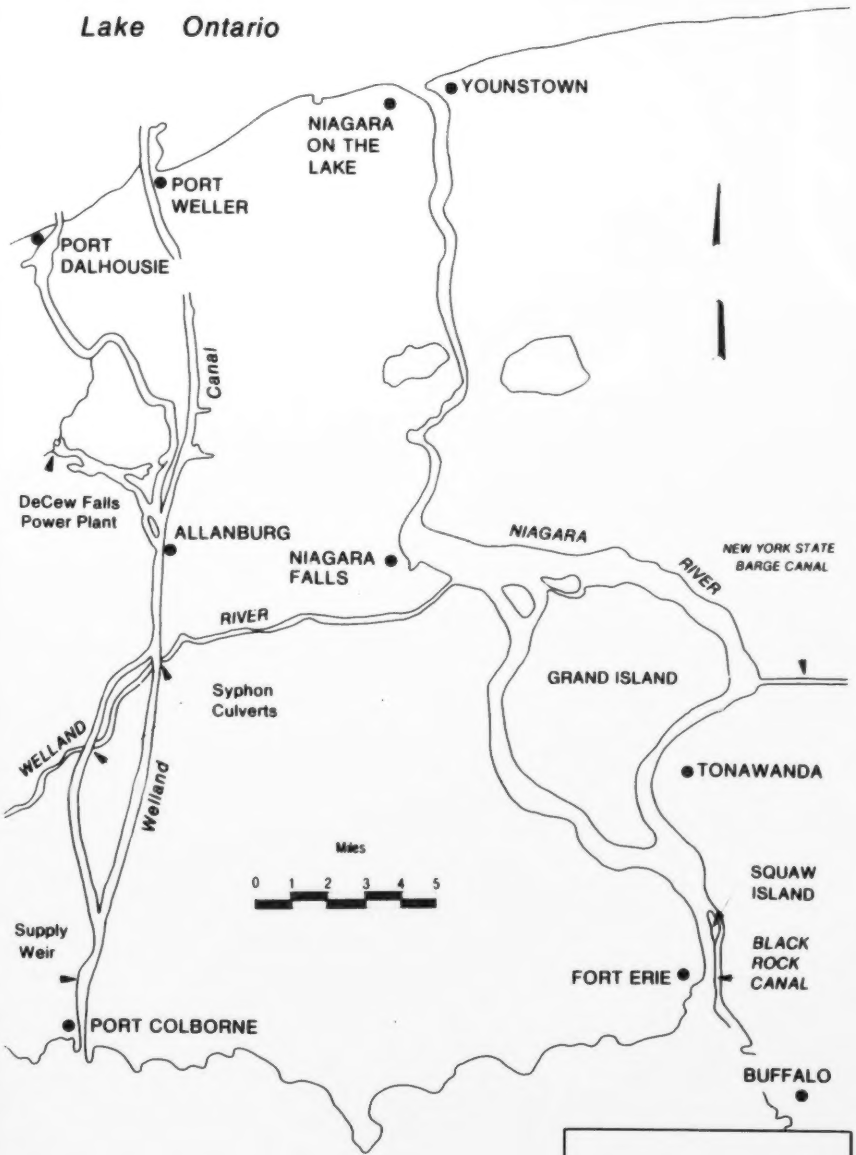
ST. LAWRENCE-GREAT LAKES WATERWAY

 LAKE SUPERIOR
AT MARQUETTE, MICHIGAN
LOW WATER DATUM 600.0
LAKE MICHIGAN-HURON
AT HARBOR BEACH, MICHIGAN
LOW WATER DATUM 576.8

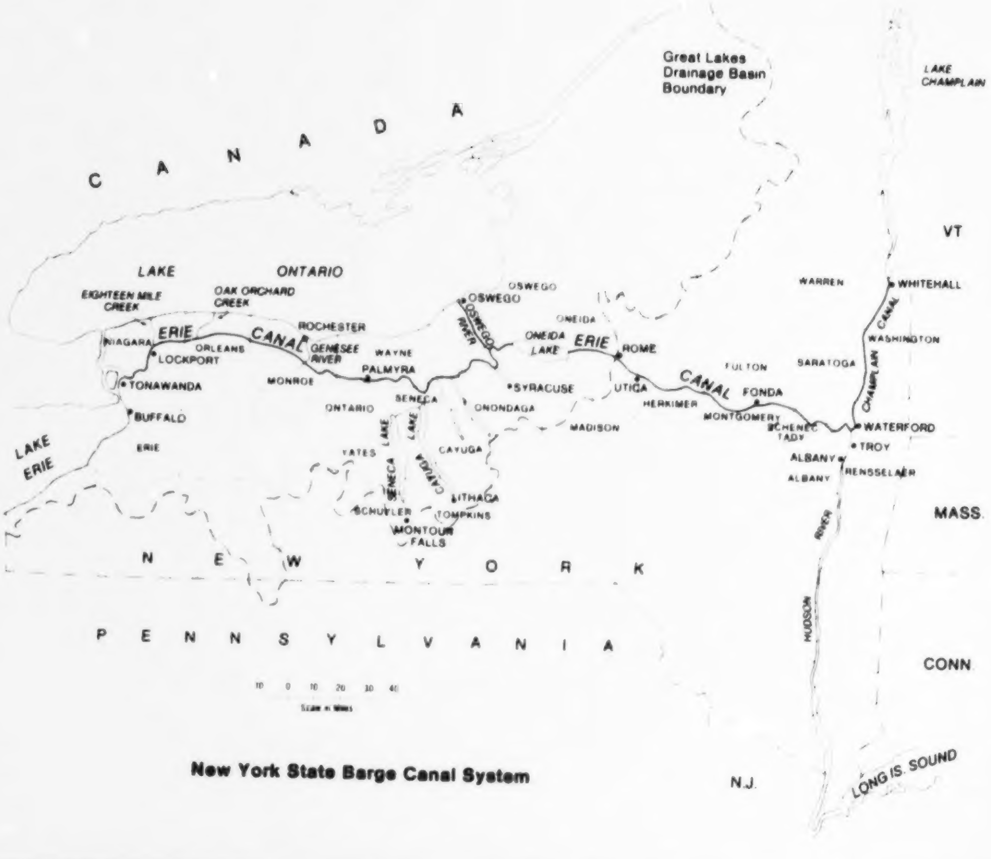

Albany
River
Basin
ALBANY
RIVER
HUDSON BAY
Basin
OGOKI
RIVER
DIVERSION DAM
CONTROL DAM
River
LONG
LAKE
DIVERSION DAM
Albany
ONTARIO
NIPIGON RIVER
CONTROL DAM



**Lake Michigan Diversion at Chicago**

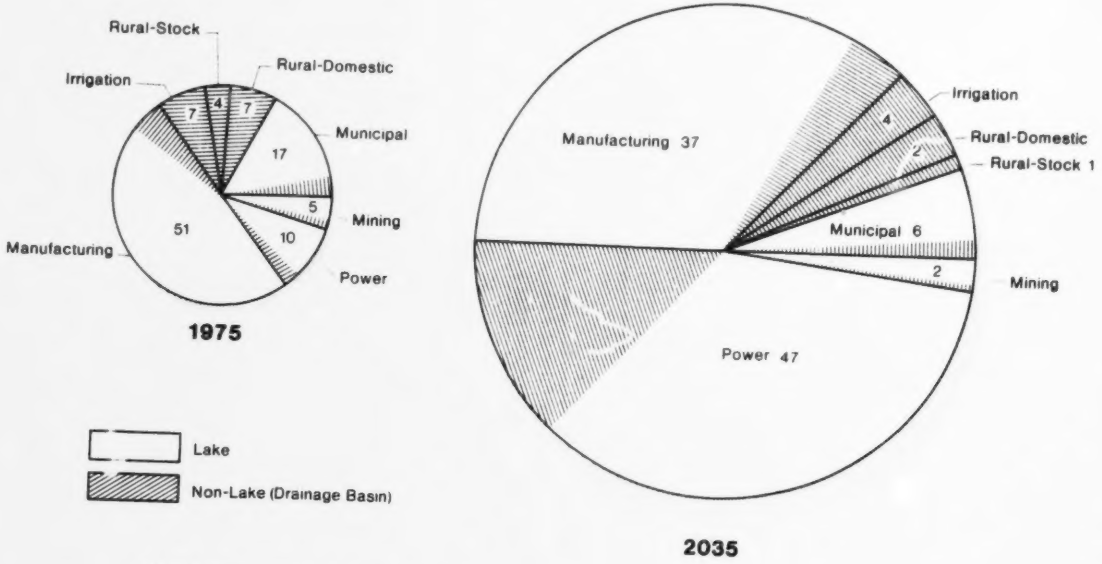


**Welland Canal Diversion**



New York State Barge Canal System

# Relative Consumption by Water Use Sectors in the Great Lakes Basin
# 1975 and 2035



NOTE: Discrepancies are due to roundings

TABLE 1

**Effect of existing diversions on mean Great Lakes Water Levels** *(in feet)*

| Diversion | Rate *(cfs)* | Superior | Michigan-Huron | Erie | Ontario |
|---|---|---|---|---|---|
| Long Lake/ Ogoki | 5,600 | + 0.21 | + 0.37 | + 0.25 | + 0.22 |
| Lake Michigan at Chicago | 3,200 | -0.07 | -0.21 | -0.14 | -0.10 |
| Welland Canal | 9,200 | -0.06 | -0.18 | -0.44 | 0.00 |
| New York State Barge Canal | 700 | 0 | 0 | 0 | |
| Combine | 5,600<br>3,200<br>9,200<br>700 | + 0.07 | -0.02 | -0.33 | + 0.08 |

TABLE 2

**Effects on mean Great Lakes Water Levels from variations in diversion rates** *(in feet)*

| Lake | Diversions | Flow *(cfs)* | Diversions | Flow *(cfs)* | Diversions | Flow *(cfs)* |
|---|---|---|---|---|---|---|
| | LL/O | 0 | LL/O | 5600 | LL/O | 5600 |
| | CHI | 3200 | CHI | 8700 | CHI | 3200 |
| | WELL | 9200 | WELL | 9200 | WELL | 2600 |
| | NYSBC | 700 | NYSBC | 700 | NYSBC | 700 |
| Lake Superior | | -0.20 | | -0.10 | | + 0.06 |
| Lakes Michigan-Huron | | -0.37 | | -0.40 | | + 0.17 |
| Lake Erie | | -0.26 | | -0.34 | | + 0.39 |
| Lake Ontario | | -0.20 | | -0.19 | | 0.00 |

*LL/O —Long Lake/Ogoki Diversion*
*CHI —Lake Michigan Diversion at Chicago*
*WELL —Welland Canal Diversion*
*NYSBC —New York State Barge Canal Diversion*

## T.W. Kierans, P.Eng.

# The Great Recycling and Northern Development (Grand) Canal

*Mr. Kierans is a Mining Engineer, with a B.Eng. from McGill University. He has been involved professionally with many large-scale mining and construction operations, including the 5,250 MW Churchill Falls underground hydro-power complex. Formerly a Professor of Engineering at Newfoundland's Memorial University, he belongs to many mining, marine and civil engineering organizations. Currently, he is President of the Southside Hills Corporation Limited of St. John's, Newfoundland, which is engaged in the design and construction of an underground complex. With his brother Kevin, he first proposed the GRAND Canal concept in 1959.*

## Abstract:

The GRAND Canal Concept proposes three integrated and interdependent water resources benefits for Canada and the United States. These are listed as follows:

1. James Bay to become a new freshwater lake with a recycling system to the Great Lakes.
2. Improved water management for the International Great Lakes—St. Lawrence System.
3. Relief for dry areas of Canada and the United States.

Concept benefits will apply directly to five Canadian provinces and twenty-five of the United States, with a total population of 160 million people. The GRAND Canal will make use of California's successful experience in similar water recycling over the past fifty years. That State has demonstrated that among the benefits of recycling is the creation of hundreds of thousands of profitable new direct and indirect employment opportunities.

This submission outlines the above three major benefits. It then briefly considers: the California experience; costs and revenues; the present Canadian position on "diversions"; and the need for a new Canada-United States water management agreement. Indirect benefits of the Concept are referred to at appropriate places in the text.

Under the section "The Challenge", this paper mentions the 800-year-old, and still in progress, diking project in Holland. It has already created a large new freshwater lake and one-third of that country's present 41,160 km² land area from a former salty arm of the North Sea. Also referred to is the 1300-year-old and 1600-kilometre long Grand Canal of China, still profitably used to this day.

This statement reports that a new Canadian company, the GRAND Canal Company Limited, has been formed with the goal of developing, managing and operating the proposed water recycling enterprise on behalf of, and under the regulation of, the public authorities which will eventually become participants.

The long-term objective of this new company will be to ensure that all regions of Canada and the United States will have access to dependable, good quality water supplies and protection against flooding.

In the Summation, the author refers to the need for such examples to all nations of peaceful, co-operative and profitable job-producing alternatives to the destructive armaments race which now employs the energies of millions of people throughout the world.

## 1. James Bay to Become a New Freshwater Lake with a Recycling System to The Great Lakes

James Bay is now a 70,000 km² salty, shallow, shrinking and under-utilized arm of the sea. It is located in the centre of a 700,000 km² sparsely populated drainage area with an average freshwater runoff amounting to eleven million litres per second, or almost twice the flow of all of the Great Lakes combined. This freshwater runoff is now totally lost to the salt water of Hudson Bay. Some of this very large and potentially valuable resource is now needed in other parts of Canada and North America.

The GRAND Canal concept proposes that James Bay should be converted into a new, stabilized and productive, sea-level freshwater lake. This will be done by constructing, within the Bay, a system of dikes or causeways designed to separate a major portion of this now wasted freshwater runoff from the salt water of Hudson Bay. It is estimated that the construction of the proposed 160 km of dikes will require about eight years. During construction, the flushing action of the continuous flow of fresh water into the progressively protected waters of James Bay will reduce its already low salinity to near salt-free levels. It is intended that a portion of this newly created fresh water will be available for recycling from the sea-level lake to the Great Lakes, and from there to other areas of need in Canada and the United States.

The recycling canal could follow several routes. A preferred course, based on present information, lies within the Harricanaw River valley. Here, a water transfer system consisting of about eight stepped reservoirs or aqueducts totalling about 270 km in length will be constructed. These will be equipped with pumps at each lift. The system will be designed to deliver, as required, from zero to full volume, up to two million litres per second of fresh water from the new lake in James Bay. This recycled water will then be transferred, via a short new canal, across the height-of-land at 290 metres above sea level, into the Upper Ottawa River near Val d'Or in Quebec. In that system, it will then flow southward via Lake Timiskaming into the Lower Ottawa. The new water will be transferred from the Ottawa River, near Mattawa, Ontario, into Lake Nipissing, and then via the historic French River into Lake Huron. In addition to moving the recycled water to the Great Lakes, the Ottawa River portion of the transfer system will be designed to substantially improve the flow and level stabilization on that river until it empties into the St. Lawrence at the Island of Montreal.

At anticipated peak demand for recycled water inflows to the Great Lakes, about 10,000 MW of electrical energy will be required to power the pumping plants. Acid rain-free energy (much of it off-peak) from Quebec's hydro-power plants and from Ontario's nuclear plants will be used.

To Canada's northern native people living in the James Bay basin, the benefits associated with the creation of the new lake an the recycling aqueducts of the GRAND Canal will include improved opportunities for education and health services, as well as leadership and economic and technical participation in the growth of Canada. The new lake will protect the existing environment for waterfowl by preserving the now-shrinking wetlands on the west side of James Bay.

With good control of the outflows of the new lake and imaginative research into its best use in a new freshwater fishery, the potential productivity of the new lake should exceed that of the present Bay. To Canadians at large, it is expected that the new freshwater lake and its water-recycling GRAND Canal will be a magnet for general development in much the same way that the fresh water of the Great Lakes has attracted a very large part of North America's population. This should improve population distribution in Canada, which is now largely confined to the southern boundary of the country.

## 2. Improved Water Management for The International Great Lakes—St. Lawrence System

Among the most serious problems now facing the Great Lakes—St. Lawrence system are those related to the stabilization of lake levels and river flows and the control of water quality. Natural precipitation on the Great Lakes Basin averages about 80 cms/year. In recent decades, it has varied from a low of about 71 cms to a high of 86 cms. Precipitation has a direct effect on lake levels. On Lake Huron-Michigan, for example, the fluctuation range, from high water to low water, is about 1.71 metres. This wide range of lake levels is very costly in several ways. Persistent high precipitation for two or more years has resulted in flooding and shore erosion. During years of prolonged low precipitation, there can be expensive low water problems for navigation, hydro-power production and for many other users of water.

With regard to water quality, modern agriculture, industry and urbanization are all increasing their consumptive uses of water. Heavy dependence on fertilizers, salt and other chemicals, coupled with rapid runoff, creates very challenging problems for water resource managers. Higher concentrations of pollutants, as well as unwelcome nutrients in the lakes, are particularly evident during low precipitation years when natural flushing is minimal. While the specific interest of the GRAND Canal concept is more directly related to water level and flow stabilization and to supply, it is clear that water quality control will require a much greater degree of supervision than it has had to date.

Because of the large area covered by the international Great Lakes—St. Lawrence basin and its many natural and population-caused complexities, localized solutions to local problems can often create new problems elsewhere on this extensive system. Examples include the Chicago Diversion out of Lake Michigan. This diversion was designed to improve water quality on the Lake Michigan shoreline in the vicinity of Chicago. However, during low water years, it has also created downstream problems for river navigation and hydro power production on the Great Lakes basin. On the other hand, Ontario's hydro power producing water diversions into Lake Superior from the headwaters of James Bay's Albany River inevitably contribute to shore erosion on the Great Lakes during high water years.

Experience and studies indicate that the best promise for improvement in the stabilization of levels and flows lies in a more comprehensive and integrated approach to water management. The GRAND Canal concept offers such a solution. It would achieve such management through integrated arrangements for new, large, dependable and fully-controllable recycled inflows to the Upper Lakes in the order of two million litres per second. These would be capable of being fully controlled from zero to their highest designed volume. The new inflows will be operated in combination with a balancing system of dependable and continuous new outflows in the order of one million litres per second. The new inflows would be designed to respond at suitable intervals to all of the changing conditions of precipitation and increased consumptive use on the lakes. The objective would be to reduce the present high fluctuations in lake levels and maintain both the new artificial, as well as the natural, outflows from lake to lake and, finally, the St. Lawrence River at their most desirable levels.

It is clear from a look at the resource map of North America that the required large, new outflows from the Great Lakes would be of great help to the dry prairie regions of Canada and the mid-west of the United States. It is also evident that the required large and fully-controllable new inflows could only originate in northern parts of Canada. The fully-controllable new inflows, "recycled" from the proposed new, sea-level, freshwater lake created in James Bay will satisfy, within one comprehensive concept, the three needs: dry regions relief; Great Lakes improvement; and northern development.

Studies have shown that, with the GRAND Canal supplying new Great Lakes inflows controllable from zero to two million litres per second, and new outflows established at one million litres per second, the present 1.71-metre fluctuations from high water to low water on Lake Michigan-Huron could be reduced to a range of 1.07 metres. This is an improvement of about 37%. It is also indicated that, with higher volumes of controllable new inflows and proportionally higher continuous new outflows, the stabilization of this key lake on the system could be even further improved.

The ultimate volume of new water available from the proposed new lake in James Bay to recycle to the Great Lakes is more than five times greater than the indicated present need of up to two million litres per second.

Clearly, such improvements in level stabilization on the Upper Lakes would benefit all Great Lakes areas including the Lower St. Lawrence River. Water quality in the Great Lakes will be substantially improved with the increased freshwater "flowthrough", providing there is no increase in the quantity of pollutants.

## 3. Relief for Dry Areas of Canada and The United States

In the semi-arid mid-west of North America, which makes up about one-third of all of Canada and the U.S.A., water shortages and ground water depletion are chronic. They now seriously restrict agriculture and industrial growth. A case in point is the area overlying the Ogallala Aquifer. This extends from western Texas to Nebraska. In this case, a report on a recent U.S. study is summarized as follows:

> *Without massive interbasin transfers, ground water level declines will continue with ultimate exhaustion. In large areas of the region, major shifts in irrigated cropping patterns, both in type and areal distribution, will occur. Large areas will revert to dryland farming or be abandoned."*[1]

Many dry regions in Canada and the U.S.A. are plagued not only with long periods of very dry weather, but these can also be interspersed with short but dangerous floods which cause severe land erosion, property damage and danger to lives. It is the objective of the GRAND Canal concept to provide both water as needed and improved flood conditions for the above areas.

The proposed new water outflows from the Great Lakes to dry areas in Canada and the U.S.A. will be carried out via a new mid-continent water relay and replenishment transfer grid. This grid will interconnect participating Canadian and United States natural river systems via suitable reservoirs, aqueducts, pumping stations, power plants and drainage canals. For example, it will relay water to a particular area of need from the designed surplus in the nearest supply reservoir. That reservoir will, in turn, be replenished from the designed surplus in the next nearest reservoir to the Great Lakes. The water transfers will then move progressively in relays closer to the Great Lakes. The new controlled outflow system from the lakes will, in this way, satisfy the cumulative water needs of a wide area. Flood control features of the grid will include both new flood storage and by-pass canals around communities.

The objective will be to assure, as far as possible, adequate water for all reasonable uses in all areas of both Canada and the United States and, at the same time, avoid flooding in any areas. The transfer grid will be operated so that water distribution to areas of need will occur without causing detrimental effects to the natural flow in rivers downstream or upstream from the transfer grid area. When electricity is not fully required for water pumping or flood control, it will be available for industrial and other uses.

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[1] *Six State High Plains Study (1976)*

### *The California Experience*

Water recycling construction in California started in 1936 with the Federal Central Valley Project. 1957 saw the start of the separately managed State Water Project which essentially expanded on the Federal plan. The two projects together recycle approximately 300,000 litres/sec for all uses. Both projects are based on the fact that 75% of the state's rainfall occurs to the north of San Francisco. Very low rainfall occurs in the southern two-thirds of the state. Topographically, California consists of an elongated basin surrounded by mountains enclosing a wide valley with San Francisco's Golden Gate providing the main outlet from the Central Valley to the Pacific. Both projects collect and store water in man-made reservoirs in the Upper Sacramento River Valley. This is the main river flowing from the north to its delta in San Francisco Bay. The reservoirs provide flood control, hydro power and regulated river flow to the delta. Just before the river's fresh water would be lost to the salt water of the Bay, it is recycled southward via the San Joaquin Valley as far as Los Angeles. Along the way, by means of over 2000 km of main aqueducts, 60 pumping stations, 42 reservoirs, 24 power plants and 40 km of tunnels, it provides water for irrigation, municipal and industrial uses, hydro power, conservation, recreation and fisheries. One pumping station alone lifts, in a single stage, 116,000 litres per second for 587 metres. The still-developing project's current plans are concentrating on water quality, agricultural drainage, recreation, fish and wildlife, and the use of underground storage. The attached 1978 data for the Federal Central Valley Project alone shows that the value of new economic activities generated by the Project is about $2.7 billion/year. The resulting new tax revenues amount to over $400 million/year. It is believed that both California projects together now generate about $1 billion/year in new tax revenues. It should be noted that California's total recycling program is approximately one-seventh of the proposed recycling rate for the GRAND Canal. In turn, this proposed rate is less than 20% of the ultimate recycling capacity of the proposed new lake in James Bay.

### *Costs and Revenues*

Only preliminary estimates can be made at this time of the investments required to implement the three essential and interdependent parts of the GRAND Canal at the proposed level of two million litres per second of variable new inflows to the Great Lakes and one million litres per second of continuous new outflows. These estimates indicate a total investment in the order of $100 billion spread over eight years of concurrent construction. About half of this sum will be spent in Canada.

Economic studies of the California water recycling experience and other large-scale water management projects have shown that the increases to economic production and to employment which result from such profitable public and personal investments have generated substantial new corporate and personal incomes. These higher incomes, in turn, provide a larger economic base which produces higher tax revenues without increasing per capita tax rates. Such revenues, augmented by appropriate user-pay charges, have been shown in California to be able to amortize capital costs, pay operating expenses and provide for system expansion and replacement as required.

In the case of the GRAND Canal, the cost-revenue budgets should, of course, include compensation to Canada as the source of the benefits provided by the recycled water.

The cost-benefit equation should also consider the environmental and other costs of *failure* to provide modern water management for the Great Lakes and relief for the mid-western water-short and flood-prone areas of the continent. This failure already imposes social and environmental as well as economic costs, without providing benefits.

Experience in California and in the James Bay power development suggests that, for this type of project and the scale of investment required, we can expect the creation of several hundreds of thousands of profitable, direct and indirect employment opportunities. Extending the Milliken study of the California Central Valley Project's Economic Impact would indicate new tax revenues alone at close to $7 billion/year.

### *The Canadian Position on "Diversions" and "Recycling"*

Clearly, Canada's participation is a key element in the proposed project. This, in turn, will be based on Canadian recognition of the fundamental differences between "diversions" and "recycling".

With regard to water "diversions", Canada has for many years been firmly opposed to increasing the 1940-43 "diversions" into Lake Superior from the Albany River headwaters for local hydro-power production. The opposition is based on the recognition that such headwater "diversions" from one watershed to another inevitably penalize future riparian wter use and development downstream from the location where the water is diverted.

A 1959 official Canadian statement on "diversions", referring specifically to U.S. proposals to increase the Chicago diversions from Lake Michigan, is contained in a Note from Canada's Ambassador to the U.S. Secretary of State. It stated in part, as follows:

> *"Careful inquiry has failed to reveal any sources of water in Canada which could be added to the present supplies of the basin to compensate for further withdrawals in the United States."*

Clearly, the "careful inquiry" had unfortunately confined itself to consideration of "diversions" only and not to the opportunities for "recycling" from sea-level as proposed by the GRAND Canal concept.

During the period between 1932 and 1938, the author of this submission was a mineral prospector in the James Bay watershed. Conscious of the very dry period in the midwest in those years, he recognized the recycling opportunity. However, it was not until the Canadian Note of 1959 had been made public that he decided to formalize this recognition. This was done on April 11, 1960 to the Canadian Parliamentary Committee on Mines, Forests and Streams. It was repeated again formally at Ottawa on March 11, 1965.

It is promising to note that, in January of this year (1984), the present Canadian government appointed a three-member "Advisory Committee on Federal Water Strategies". It is hoped that this Committee wil give serious consideration to the very basic differences between "diverting" and "recycling" from sea level. In the latter case, of course, Canada will not only avoid the loss of water by diversion, it will, in fact, add to its existing supplies and, at the same time, make possible the inter-dependent benefits proposed by the GRAND Canal concept.

### *A New Canada-United States Recycled Water Management Agreement*

A necessary prerequisite to this Concept's implementation will be a new agreement or an updating of the present Treaty betwen Canada and the United States. The Boundary Waters Treaty of 1909 now governs those waters ". . . along which the international boundary between the United States and the Dominion of Canada passes." These include parts of the Great Lakes-St. Lawrence system but exclude ". . . tributary waters which, in their natural channels, would flow into such lakes, rivers and waterways of rivers flowing across the boundary . . ." The 1909 Treaty established the present International Joint Commission to ". . . pass upon all cases involving the use or obstruction or diversion of the waters . . ."

Clearly, this Treaty does not deal with the recycling of fresh water from a new lake to be created in James Bay, nor does it consider the water needs of regions distant from the boundary. Nevertheless, with expanding populations in both countries, water needs are becoming ever more pressing. it is needful, therefore, that Canada and the United States should soon formally consider the opportunities for mutually profitable trade in recycled (not diverted) fresh water. Very briefly, such considerations would include the following:

> *Riparian law and its place in water transfers, compensation, water ownership, water management, public participation and regulation, financial feasibility and guarantees, ownership of transfer structures, water quality standards, quantity measurements and controls, airborne water pollution, the protection of higher-quality water against lower-quality water (e.g., the Garrison transfer problem), ground water conservation and protection, water reclamation and re-use, flood control, hydro power generation, navigation, recreational use of water, fisheries, water conservation, and the unreasonable use of water.*

It is hoped that the opportunities suggested by the GRAND Canal concept will soon initiate such formal considerations.

### *The Challenge*

Some fifty years ago in California, the recycling of the Sacramento river's outflow from the northern half of the state to the southern half began. The total investments in the separate federal and state water projects up to 1983 equals about $20 billion. The Central Valley project alone is reliably reported to support directly and indirectly 128,000 jobs. Both have provided flood control, recreation facilities, electric power and water for the state's municipalities, industry and agriculture. The annual crop value alone exceeds $10 billion per year. Based on the current state population of 23.68 million people, the per-capita cost has been about $17.00 per person/year, spread over fifty years. Many of the project's features will last several lifetimes, at least.

In contrast to the California experience, the five Canadian provinces and twenty-five states of the U.S.A. which will benefit from the GRAND Canal have a total population of about 160 million people. Based on an estimated investment of $100 billion, which for comparison should also be spread over fifty years, the per-capita cost will be $12.50 per person/year.

The challenge here is not in the validity of the concept nor in the availability of the physical or the economic resources to do the job. It is not even in its political and social complexities, formidable as these may be. The major challenge here lies in the willingness of representatives of both Canada and the United States to clear their minds of historically fixed positions so as to examine and study the mutual benefits that both of these neighbouring countries can gain from this comprehensive and integrated approach to North American water management. With this done, there are existing precedents, such as the St. Lawrence Seaway and the Niagara Power Treaty of 1950, for the resolution of problems of sharing the important benefits and the costs.

However, it should be emphasized again, as in the case of the St. Lawrence Seaway, that the mutual advantages are interdependent and not separable. For either Canada or the United States to acquire any benefits whatever from the concept, joint and co-operative approvals for the implementation of the full and integrated concept will be required from both countries.

In this regard, both Canada and the United States would appear to be at the same decision-making stage, with regard to water, that Holland was at when it decided, eight centuries ago, to start the construction of the dikes that now provide abundant fresh water and permit agriculture and industry to flourish in what was formerly a salty swampy arm of the North Sea.

Or it may be that we are at a similar stage to the China of 605 AD when the 1600 km long Grand Canal of that country connected the delta of the Yellow River of the north to that of the Yangtse River of the south. Marco Polo marvelled at this engineering accomplishment in 1275. To this day, the Grand Canal of China continues to profitably serve that ancient but still young and vigorous country.

It should also be said that a major interest for Canada, at this time, is that the economic and political stakes are very high. Reflection on past experience will show that Canada should move forward *now* to maintain the benefits of leadership in the studies of the social, economic and technical opportunities in large-scale water recycling and management which are presented by this North American GRAND Canal concept. If we fail to do so, the economic advantages of initiating such studies could slip through our fingers and find more meaningful technical and economic leadership outside of this country.

### *The GRAND Canal Company Ltd.*

With the purpose of bridging the critical gap between an engineering concept and a construction project and ensuring that, as far as possible, technical and economic impetus and leadership remain in Canada, the GRAND Canal Company Ltd. was recently incorporated. This is a Canadian company, incorporated and owned by Canadians. It will seek to provide the on-going focus for the continuation of more than twenty-five years of engineering development and promotion of the GRAND Canal concept carried out by T. W. Kierans, P. Eng., one of the two authors of the concept. This new company has already attracted the attention of experienced professional organizations and individuals interested in participating in the required detailed economic, social, environmental, engineering and other studies which will be necessary in order to obtain the approvals in principle of the several governments involved.

The company's ultimate goal is to develop, manage and operate the GRAND Canal project on behalf of and under the regulation of the international, national and provincial public authorities participating in the project.

## Summation

The GRAND Canal offers three direct but *interdependent* water resource benefits for about 160 million people in both Canada and the United States.

The proposed recycling concept has already been proving in California to be an effective and profitable method of bringing improved freshwater management to broad area of need. Experience has shown that the implemention of this type and scale of enterprise will result in the creation of several hundreds of thousands of new, direct and indirect profitable employment opportunities. These will initiate new waves of confidence in this continent's economic system. Many areas of international friction betwen Canada and the U.S.A., such as the Chicago and Garrison Diversions and troublesome Great Lakes water management problems, could be resolved with the implementation of the GRAND Canal.

Additional indirect benefits, such as a shorter and soon much-need new Ottawa River navigation route to the Great Lakes, could follow its implementation.

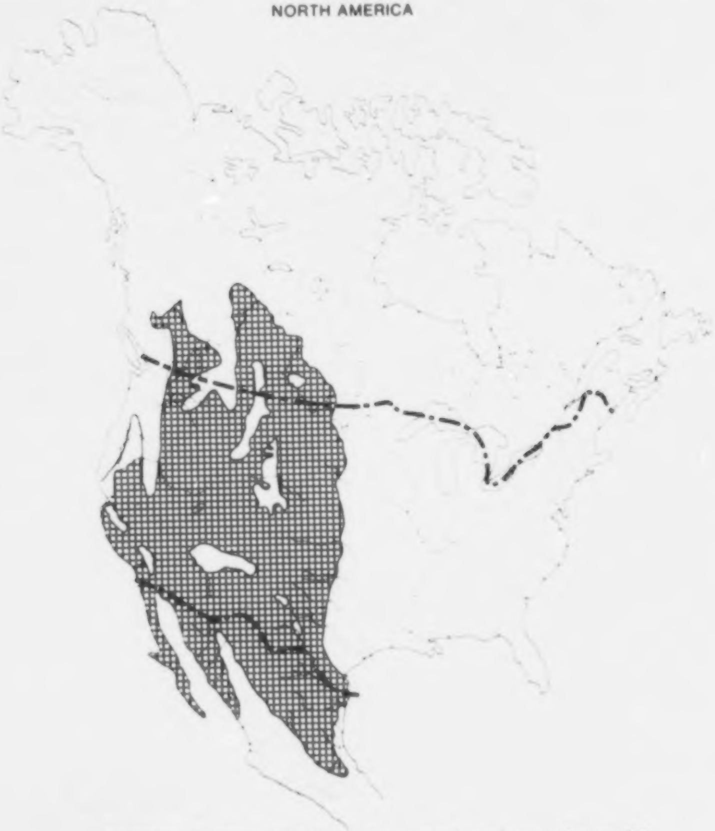
Above all, when the GRAND Canal becomes a reality, as it surely must, it will demonstrate again, as the St. Lawrence Seaway has already done, that both Canada and the United States have the joint leadership and determination to *co-operate* in protecting and improving the quality of the physical, social and economic environment for all the people who live in *all* parts of North America.

It should also be said, in the interest of international peace, that such large-scale examples of *productive, international co-operation* may prove to be not only the best, but perhaps the *only* job-producing alternatives to the much more costly and destructive armaments race which now clouds the future of our world.

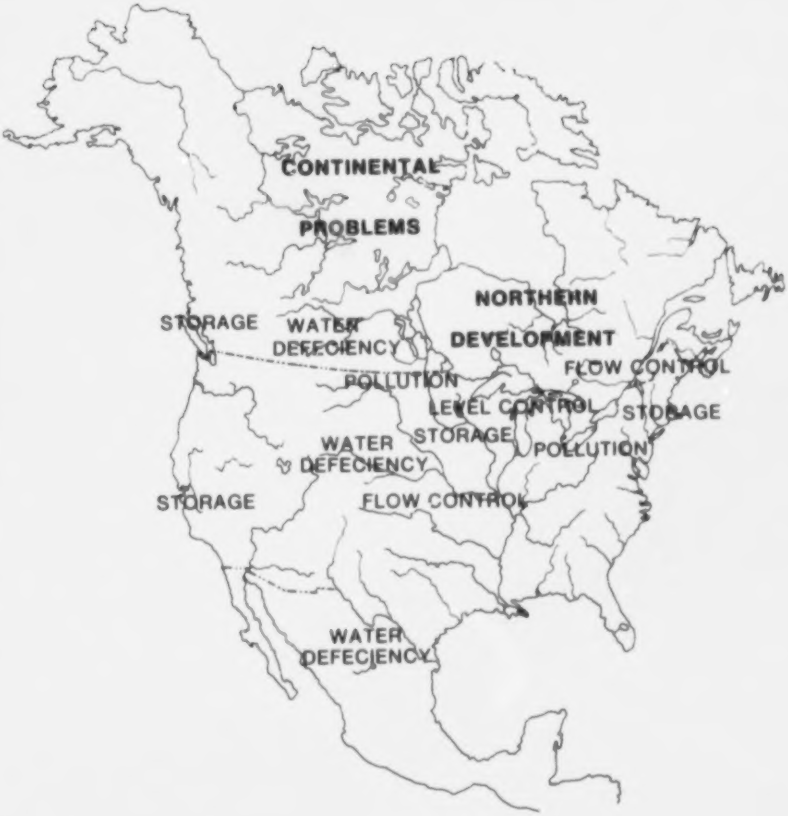
A former Prime Minister of Canada, the Right Honourable Lester Pearson, has said: "The future task for the people of Canada is to become more Canadian at the same time that we become more North American."

The GRAND Canal offers a practical, profitable and proven answer to the achievement of that sensible goal.

WATER DEFICIENT REGIONS
OF
NORTH AMERICA



Based on data compiled by UNITED NATIONS and reported in the National Geographic, November 1979


CONTINENTAL
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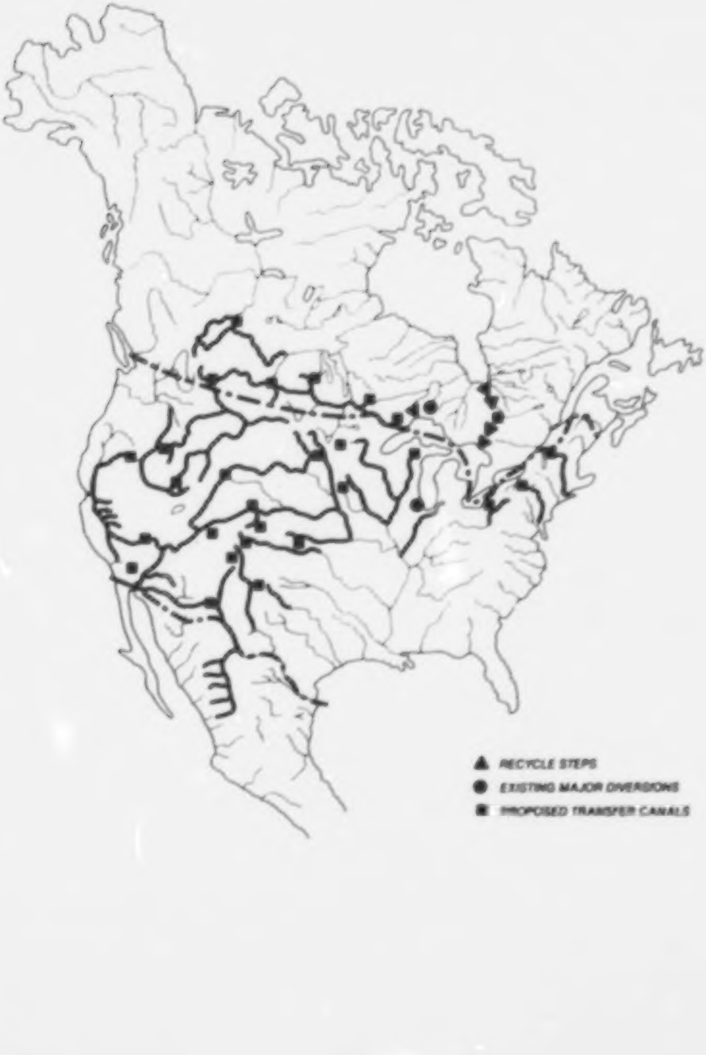
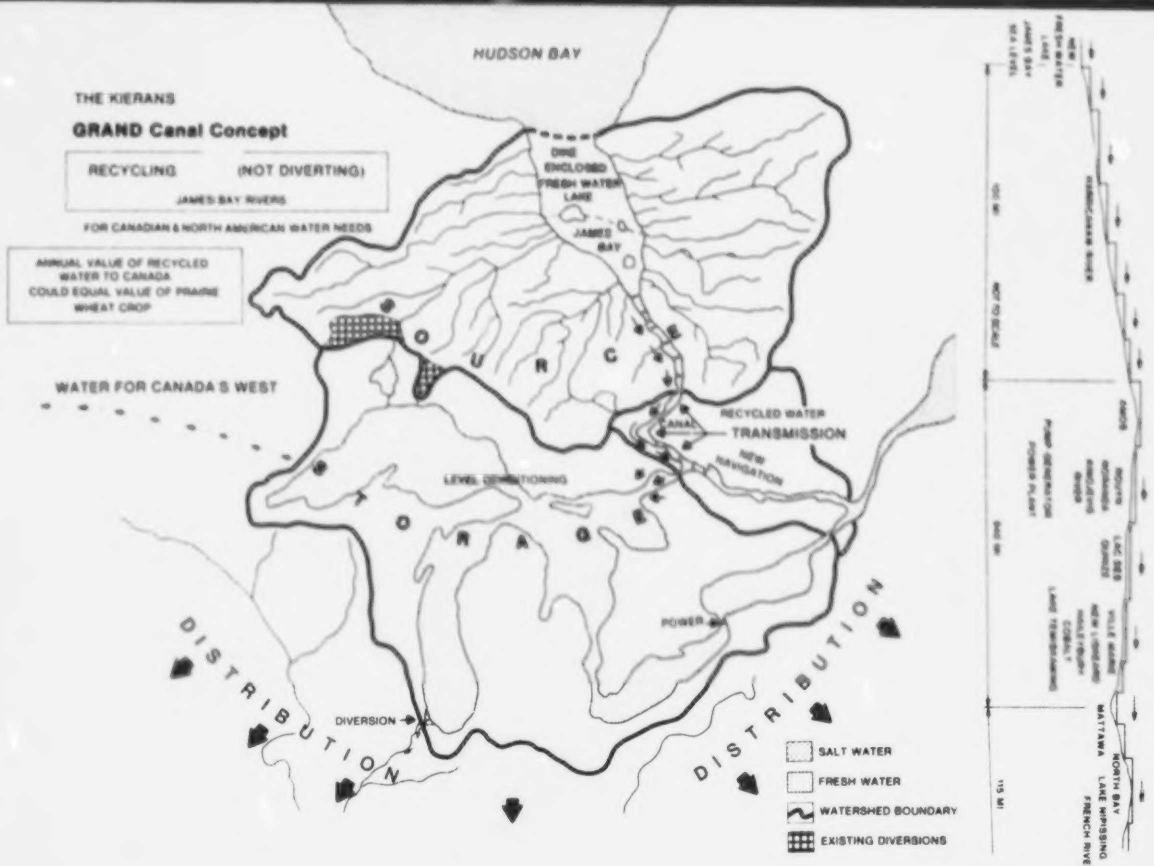
THE GRAND CANAL CONCEPT
A PROPOSED DISTRIBUTION SYSTEM




THE KIERANS
GRAND Canal Concept
RECYCLING
(NOT DIVERTING)
JAMES BAY RIVERS
FOR CANADIAN & NORTH AMERICAN WATER NEEDS
ANNUAL VALUE OF RECYCLED WATER TO CANADA COULD EQUAL VALUE OF PRAIRIE WHEAT CROP
WATER FOR CANADA'S WEST
HUDSON BAY
DIKE ENCLOSED FRESH WATER LAKE
JAMES BAY
SOURCE
RECYCLED WATER
CANAL
TRANSMISSION
NEW NAVIGATION
LEVEL CONDITIONING
STORAGE
POWER
DIVERSION
DISTRIBUTION
DISTRIBUTION
SALT WATER
FRESH WATER
WATERSHED BOUNDARY
EXISTING DIVERSIONS
NEW FRESH WATER LAKE
JAMES BAY SEA LEVEL
HARRICANAW RIVER
100 MI
NOT TO SCALE
AMOS
ROUYN NORANDA
KINOJEVIS RIVER
LAC DES QUINZE
PUMP GENERATOR POWER PLANT
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NEW LISKEARD
HAILEYBURY
COBALT
LAKE TEMISKAMING
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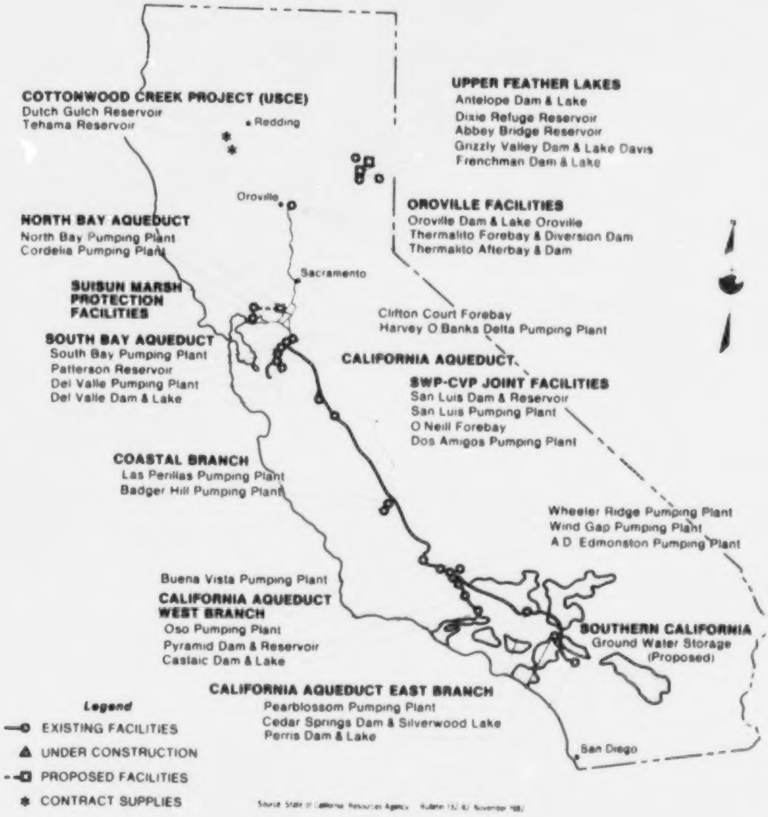
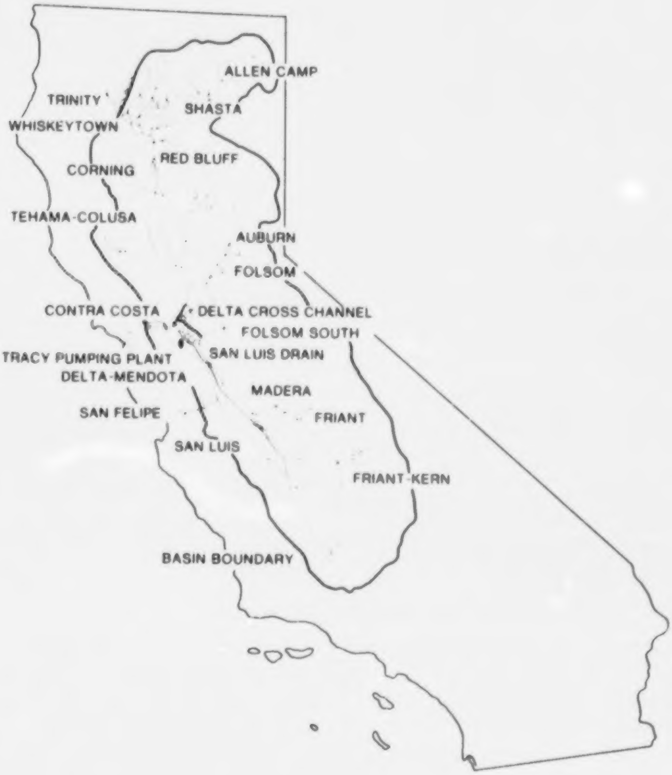
MATTAWA
NORTH BAY
LAKE NIPISSING
FRENCH RIVER
115 MI

## CALIFORNIA STATE WATER PROJECT
## WATER FACILITIES



Source State of California Resources Agency Bulletin 132-82 November 1982

***Central Valley Project***



Date 79/10/27

**Estimates of Output, Personal Income and Corporate Profits Generated by The Central Valley Project, 1978** *(million $)*

| | Total Tax Base | | | Internal Revenues Generated | | | |
|---|---|---|---|---|---|---|---|
| Type of output | Net Value of output | Personal income | Corporate profits | Personal income | Corporate profits | Indirect Business taxes | Total |
| Service Activity | 164.3 | 114.0 | 10.8 | 17.1 | 4.6 | 2.2 | 23.9 |
| Agricultural Water: | 1,857.4 | 1,216 | 193.5 | 182.4 | 82.4 | 27.9 | 292.7 |
| Crops | 963.6 | 676.6 | 67.1 | 101.5 | 28.6 | 11.4 | 141.5 |
| Livestock | 59.8 | 41.6 | 3.6 | 6.2 | 1.5 | .7 | 8.4 |
| Food Processors | 834.0 | 498.2 | 122.8 | 74.7 | 52.3 | 15.8 | 142.8 |
| M & I Water: | 15.5 | 7.9 | .9 | 1.2 | .4 | .2 | 1.8 |
| Water Districts | 15.5 | 7.9 | .9 | 1.2 | .4 | .2 | 1.8 |
| Dependent Industries | | | | | | | |
| Hydroelectric Power: | 254.1 | 95.5 | 50.3 | 14.3 | 21.4 | 1.0 | 36.7 |
| Utilities | 254.1 | 95.5 | 50.3 | 14.3 | 21.4 | 1.0 | 36.7 |
| Dependent Industries | | | | | | | |
| Recreation | 47.2 | 30.8 | 5.1 | 4.6 | 2.2 | .9 | 7.7 |
| Capital Investment | 350.8 | 228.9 | 34.5 | 34.3 | 14.7 | 6.7 | 55.7 |
| Totals | 2,689.3 | 1,693.5 | 295.1 | 253.9 | 125.7 | 38.9 | 418.5 |

The above data is from "The Economic Impact of the Central Valley Project" by Dr. J. Gordon Milliken, Senior Research Economist, Denver Research Institute, University of Denver.

*Note:* This 1978 data is for the Central Valley Project alone. The more extensive State Water Project will exceed the revenue data shown. It is estimated that the two water projects together recycling 300,000 litres/second now generate about $1 billion/year in tax revenues and provide 250,000 employment opportunities.

## Ms. Sally Barnes

***Former President,***
***Ontario Status of Women Council***

# A Layperson's Views on Emerging Water Issues

*A native of Napanee, Ms. Barnes worked as a reporter for newspapers in Kingston, Ottawa and Toronto, and for CITY-TV. While covering the Ontario Legislature for the Toronto Star in 1972, she became the first woman President of the Queen's Park Press Gallery. She was awarded the Southam Fellowship for Journalists in 1973, and was appointed Press Secretary for Premier Davis in 1975.*

Mr. Chairman, Ladies and Gentlemen.
I am honoured to address this important Conference.

I come before you today as one who has spent all of her adult life in either journalism or public service, and I would hope to bring to you some thoughts from the perspective of an ordinary citizen who happens to care very much about the subject you are discussing.

I care, ladies and gentlemen, because it is very much a social issue. It will have a tremendous impact on the lives of our children and grandchildren here in Ontario and elsewhere.

I care, as well, from a political perspective. I make no apologies for my patriotism. As one who has travelled a fair amount, I always return home more thankful than ever for my citizenship. I sincerely believe that we Canadians are indeed one of the most compassionate, fair and just societies on the face of the earth.

This does not mean we are perfect. We are far from it. But I believe we have, at most times throughout our history, done what was fair and decent and right, and I believe we will react in this fashion in dealing with the subject at hand.

But we will do so only after the ordinary men and women of this province understand the water quantity issue, its costs and its consequences.

And therein, in my view, lies one of the major challenges before you. I respectfully submit that you face a communications challenge and I would like to deal with that, drawing somewhat on my experience as both journalist and as one who has worked for the Government of Ontario for seven years in a Public Relations capacity.

But before I get to the need to inform, let me assure our American guests that my patriotism does not preclude in any way my tremendous admiration and respect for the United States. You are indeed the most generous nation on the face of the earth. I confess that, like so many other Canadians, I have often resented your power and influence over us. As you are possibly aware, our children know more about George Washington than they do about our first Prime Minister, Sir John A. MacDonald, and, of course, it's easier to blame you for that than ourselves.

I have so many times resented the fact that I know so much about your history, geography and culture, and you know so little about mine.

According to U.S. newspapers and television network news, the only thing that happens in Canada is that we regularly export to you yet another cold air mass. Ontario alone exports more, of course, than cold air to the United States. In fact, Americans buy more from our province than they do from that better-known trading partner of yours, Japan. That's a subject for another day, however.

Like so many Canadians, I have often quarrelled with your policies, and we will continue to do so when they affect us adversely. There is valid concern in this country right now over U.S. fiscal policy because we are tied so closely to you in our prospects for economic recovery. It is true that when America sneezes, Canada catches pneumonia!

But I want to emphasize to you that, despite concerns of this sort, we continue to rejoice with you in your many accomplishments, we continue to cry with you in moments of national tragedy, and we appreciate how much our unique relationship has benefitted Canada. How often we as Canadians have dined at your table, heading back home when it was time to pick up the cheque!

And Americans, of course, have benefitted greatly from their association with us.

All of which leads me to the point I want to make. I believe the subject before us at this Conference represents a very great potential for serious conflict between our two great nations and our long and enviable friendship. But I also believe that, if there are two nations on the face of the earth with the moral fibre and historic ties to work this thing out, they are the United States and Canada.

And I say that despite the fact that Paul Robinson remains U.S. Ambassador to Canada, rolling around like a loose cannon on our decks up here. I am joking about Mr. Robinson, of course. I am among the many who anxiously await this evening when he will be your guest speaker. In my view, he brings a welcomed honesty and candor to the world of diplomacy.

And speaking of candor, I believe that one of the secrets to maintaining a good friendship is the ability to be honest with each other and to discuss potential conflicts when the warning signs first appear.

I believe many of us who follow the media have detected some warning signs that lead us to worry about our long-term relationship and whether this traditional friendship of ours might be showing a few signs of wear and tear.

I refer, for example, to recent U.S./Canada boundary disputes on the east and west coasts.

Canada and the U.S. are now before the International Court of Justice in The Hague in a dispute over who should get what part of the rich fishing grounds in the Gulf of Maine off the East Coast.

Also at stake in this boundary dispute are potentially huge reserves of offshore oil and natural gas.

The bickering began in 1977, when Canada and the United States extended their fishing zones to 200 miles, and in the Georges Bank part of the Gulf of Maine where their boundaries overlapped.

The World Court will resolve the seven-year dispute by establishing a maritime boundary.

Meanwhile, on the west coast, another U.S./Canada boundary dispute is brewing over a 400-square mile area in the Dixon Entrance, where the Alaska Panhandle meets the coast of British Columbia.

Canada has protested to the U.S. State Department that Canadian sovereignty was violated by a notice from the U.S. Department of the Interior which advertised leasing rights for exploration and development of that area of the continental shelf.

As examples, I put those cards on the table in suggesting that, as neighbours, we perhaps have some fence mending to do; we should perhaps not be taking for granted that our much-touted friendship will prevail when the going gets tough.

In the case of water supplies which will so affect every man, woman and child, I believe we have to take the case to the ordinary people of our two countries. I believe it would be a very serious error to leave this matter to lobbyists in Washington or to some group of experts whose expertise may well be the legality of the arguments, not the morality of long-term social costs.

I continue to have great faith in the ordinary people of our two countries. I, too, have often bemoaned the apparent indifference with which too many in our society react to public issues. But I have also been tremendously encouraged by the depth of concern and commitment by the great majority of our people over issues affecting themselves, their families and their futures.

No one in this room should waste a dime polling the Ontario public on the degree of concern over water quantity resources here in our province. I can tell you quite frankly the public doesn't give a damn because the public has little or no idea that there is a problem or ever will be a problem over water quantity.

While the media on the American side of the Great Lakes has given significant attention to the water quantity and diversion issue, coverage here in Ontario has been almost nonexistent. Newspaper libraries can cough up only a few articles on the important subject.

This is one reason that this Conference is so important. Here in our own front yard we have attracted some of the foremost experts to discuss this subject, and the media is paying it some attention.

The challenge of this Conference, and in the days and weeks which follow, is to put the subject in terms our ordinary citizens can understand and to which they can relate. We must encourage many to become interested in the debate.

It will not be easy. To talk of water shortages in Ontario is like discussing hunger at a feast.

It is hard to whip people into a frenzy on the subject when we have some 228,000 lakes among us; water accounts for some 17 per cent of our province; we know that the Great Lakes is the largest chain of freshwater lakes in the world, containing some 18 per cent of the world's fresh water.

Well, it wasn't that long ago we though we had infinite supplies of energy as well. I suggest to you that, as surely as the public faced the reality of depleting oil supplies, there is an obligation to inform the public that our water supply is also finite, with even more devastating consequences if we do not learn to respect and reserve this great resource we now take for granted.

As surely as oil was the issue of the 1970s, water will be the issue of the 1990s and beyond.

I believe a public education and conservation program is an obvious place to start. And our schools have to play an aggressive role in any such program. That is fitting, of course, because it will be our children and their children who will, in their lifetimes, reap the consequences of today's waste and mismanagement.

I believe an informed public will respond.

Business people will react to the knowledge that a drop in lake levels will mean less water for hydro-electric generation and reduced commercial shipping, with attendant higher costs. This is pretty sobering when one considers that water power produces about one-third of our total electric energy in Ontario and our ports handle about 74 million tonnes of goods on the Seaway and Great Lakes each year.

The value of water, in commercial terms, can also be stressed by the reminder that it takes some 250,000 litres of water to produce one tonne of steel, and 10 litres to produce one litre of gasoline.

To homemakers, ordinary taxpayers and families, there is an almost endless list of examples that can be used to stress the importance of water in our daily lives and the way we now abuse the resource. To cite but a few:

In Ontario's urban areas, each person uses about 395 litres (100 gallons) of water daily just for domestic purposes. Little of this is used for drinking. Some 30 per cent goes for bathing, and 45 per cent for flushing toilets.

We now have little appreciation of just how much water we use. One expert has remarked how we get our shorts in a knot over a leaky tap in the kitchen, while a water-cooled air conditioner in the basement is spewing gallons of clean water down the drain. There is a message in that, however. We are worried about the tap because an aggressive, effective energy conservation program taught us we should be worried about such things.

We have to remind our citizens that, during the energy crisis, we sought and developed alternative sources of energy. But there is no alternative to water. What you see is what you get.

I believe our children might be a little more respectful of water if they were reminded that it takes up to 40 gallons to take a bath; 30 for a shower. It is estimated that two and a half pounds of bread probably requires 300 gallons of water to develop from seed to milling wheat.

These statistics would surely be effective, but indeed the best argument might be along the lines of the costs to the consumer.

A tremendous amount of water is required in food production. As water becomes more and more scarce, its value will increase, and the cost of everything which depends on it will increase. Food is but one obvious but very crucial example.

The point I am attempting to make, ladies and gentlemen, is that it's not good enough to remind the public that roughly three billion gallons of water a day are being permanently removed from the Great Lakes alone.

As an ordinary citizen, I quite frankly am impressed with that figure, but I cannot relate to it. It is too overwhelming. But, provide me with a tax incentive to market or install a more efficient toilet or convince me that water conservation is of direct benefit to me and my family and our way of life, and you will have won a convert to your cause.

I am loathe to admit it, but I fear that the real carrot will be economic incentives. We learned to conserve energy partly because we recognized the immorality of wasting finite resources and the consequences energy shortages would have on our way of life.

But let's be honest with each other. Most of us became energy conscious because of the price tag involved. We designed and bought smaller cars, not out of patriotism but to save money when gas became expensive.

We began turning out lights when electricity costs increased.

Here in Canada, thousands of us converted our oil furnaces to gas or switched to electricity because our governments gave us tax incentives to do so.

I suspect that only when we have to start paying more for our water will we truly commit ourselves to giving it the value it deserves and determining to conserve it and replenish it.

Increasing the cost of water would not be a popular political move, of course. But I believe it may well be a direction in which politicians will have to head if they are serious about dealing with the problem by shaping public opinion and getting public support on the many issues involved in the water quantity debate.

In my view, history will be very cruel to those leaders of the '80s who fail to take a leadership role on this important subject.

But, in more contemporary terms, I believe our fellow citizens today will demand more attention be given to water quantity once they know the facts which up to now have eluded all but a dedicated and concerned few.

I believe our citizens would not object to reasonable tax measures whose revenues would be allocated to conservation incentives and research and development of water replenishment programs.

Quite simply, all of us at this Conference have an obligation to tell the ordinary men and women of our countries what you already know. And you have to tell it in a manner all can understand and appreciate.

Responsible leaders will have the support of an informed public in allocating the time and money necessary to finding the solutions.

Here in Ontario, our record in water conservation is an enviable, one, dating back more than four decades. Today, we benefit from the wisdom of the "futurists" of our grandparents' generation and we will expect future generations of Canadians to be as well served.

The news media will have their fancies tickled by suggestions that our two countries might well be at war one day over water. Well, those will make interesting headlines and they will certainly bring to the public's attention an appreciation of the subject at hand. And they will therefore serve a purpose.

I do not believe we will be at war over water.

I have faith in the basic decency of our people and confidence in the common sense of our leaders to act now to take the kind of initiative to meet the great water quantity challenge.

I believe that, here in Canada, the ordinary men and women of Ontario will expect our governments to take a firm stand on the diversion issue, recognizing it as a question of basic sovereignty and the basic well-being of our people and our future.

But no one should be so naive as to believe that we can or would attempt an isolationist attitude and continue to wantonly swallow up water supplies while our neighbours slowly die of thirst. It wouldn't be legally or technically possible, of course. But, more importantly, I believe Canadians are made of better stuff when it comes to moral issues like that.

Throughout Canada and the United States, not just in the Great Lakes area, we must hammer home the truth about water quantity and what is at stake.

Throughout Canada and the United States we must develop a better understanding for each other and our mutual needs. Americans must learn to appreciate there here in Canada we are not some kind of backwoods colony of ice and snow and quaint customs. We are a vibrant industrial nation of huge potential, every bit as dependent on our water supplies as the next guy!

I believe it will be very tragic if the diversion debate drives a serious wedge between our two great nations.

The tragedy would be especially profound because it would be needless.

By working together now, we can find the solutions. We can find the technical know-how if we can find the resolve and backing of our people and their leaders.

The ordinary men and women of Canada and the United States have long become accustomed to expecting that that's the way things will be done between us.

As one of those ordinary citizens, I tell you as passionately and as strongly as I can that that is the way this matter must be resolved.

There is simply too much at stake in terms of our reputations and the basic survival of our people and our way of life to abandon history and principle and strike out on any other course after all these years together.

It has been a good marriage. It will remain so if we can continue to respect each other's individuality while reminding ourselves of just how important our partnerhsip is, not only to us, but to millions around the globe who look to North America as a beacon of hope in a selfish and angry world.

Thank you. And good luck!

## Session 2—Questions and Answers *(Edited)*

*Question:*
Harvey Clare from the Conservation Council of Ontario. I'm not so sure this question is at these panelists up there, but I was somewhat curious and taken aback by the statement given by our Minister, Alan Pope, this morning about telling the Americans how to use cooling water. He was suggesting that, instead of using cooling towers, we ought to take what I think is a retrograde step back to using once-through cooling water.

Now, I worked 40 years in industry and I worked with 2 or 3 governments in setting up standards, effluent standards, for oil refineries in which we worked to reduce the quantity of water we used by such methods as cooling towers, and we got down where we could then have a manageable amount of water to treat. So, in this case, it's certainly a quality problem. I really am a little perplexed about how once-through cooling is really the real answer.

The other point is that, since we are talking about an ecosystem approach, the water that does evaporate from cooling towers stays in this ecosystem basin and I'm sure it falls back on us, so that has a double flip to it.

*Moderator:*
Any one on the panel want to comment on that? The point is well taken, if we save on the evaporation, we lose on the thermal discharge, and there has to be a balance here in the ecosystem point of view so there isn't a quick solution to what you are talking about, and it does have to be put back into proper perspective to the ecosystem.

*Question:*
Yes sir. Observations rather than question. My name is Anand. I'd like to make some observations about the concept of time element. The water in our rivers which is flowing today is different from the water which was there yesterday and it is different from the water which will be available tomorrow. In 1964, when Churchill Falls was not getting off the ground, I wrote a paper that estimated that 35 million dollars worth of intrinsic value of water was wasted in one year's delay of water power on that particular river in Newfoundland. In the light of that, I support Mr. Kieran's scheme, which was discussed in 1965. Can you imagine the amount of potential benefits which have been lost between 1964 and 1984, a period of 20 years. The sums are mind-boggling. Now, in the light of this, the concept of reserving rivers for future generations is erroneous. And it leads to a lot of anomalies in water management and water policy.

An American friend of mine was grumbling that he wasn't allowed 50 cfs diversion.

50 cubic feet per second translates to over 300 gallons per second, and it translates again to 26 million gallons per day. If you put the sum of 1/10 of a cent per gallon on this water, it will amount to $260,000 per day, and that is what he was asking that was not allowed to divert. In that regard, once again, when Americans sell oranges to us or we sell apples to them, do we do it free of charge because they are renewable? Now, you cannot have all this water without putting a value on it.

*Question:*
Mr. Derek Foulds, from Ontario. There is something the matter with communication, and I was interested in Sally Barnes' comment. I've had the problem of trying to catch people's attention on water problems for most of my life, and I wonder how she would react to a suggestion that the way to catch people's attention about water was to turn it off for about 10 hours.

*Sally Barnes:*
Well, I tell you, hell hath no fury like a householder that would put up with that. I mean the next time that poor politician responds to the polls, I mean he or she would suffer the consequences. No, I don't think we have to resort to that, quite frankly. I think that there are other ways. We start with school kids. We did it on energy. I think we can do it on water. We've got some of the best communications people in the world here in Ontario. We can do it if we set aside the money to do it and the time. I think what we need is the basic resolve, and the people are available. It's just a case of having the resolve to start it. I guess you could resort to that.

But, my land, I would hope that that would be a last ditch effort, quite frankly. It would certainly work, wouldn't it?

*Question:*
I'm a Consulting Engineer from Toronto. I was interested to hear Mr. Keiran's plan for James Bay. It certainly is imaginative, and that is the only thing that's going to get any one to support it. I was just wondering, though, if Mr. De Cooke could tell how that water should be used when it hits the Great Lakes and what effect its addition would have. The Great Lakes are a vast reservoir and it takes a lot of water to have any effect at all, and, even then, the effect may take years to come about. Not just a matter of turning on and off a tap. I wonder if Mr. De Cooke could elaborate on that somewhat.

*Mr. De Cooke:*
I really believe Mr. Kierans ought to answer that question, because I guess he and I have a basic difference. My feeling, of course, is that we should learn to manage the resource within the system before we contemplate bringing water from outside the system basin. Lakes Michigan, Huron and Erie are not regulated lakes and to accomplish what he is suggesting, when long-range forecasts are not with us so that we can manipulate the tap as he would call it to keep the levels constant, the system isn't that responsive. As I pointed out, the systems do have an effect, putting water into the system or taking water out of the system can be felt as long as 15 years in the system. Water taken out of Lake Michigan at any point in time will be felt on Lake Erie for the next 30 months. We recently had an ice jam on the St. Clair River which will be an impact on Lake Erie and Lake Ontario for years to come. There was a high economic loss sustained by that ice jam, both to navigation and to power interests. Sure, the water remains on Lake Michigan, but about 2/10 of a foot. Economic loss to the shore property due to inundation and erosion, if storms were to hit, that 2 inches would add considerably to that damage.

*Mr. Kierans:*
Yes. There is really no problem. We recognize everything that Mr. De Cooke recognizes in the area. However, we went to the trouble, and I say that includes a gentleman who is unfortunately not here and I have not asked his permission if I could use his work. But I think he's one of the most competent hydraulic engineers in the course of my history, and he took the trouble some years back to go back 50 years and build the Grand Canal, and then make adjustments to it over those years, bearing in mind the hydrometeorology that prevailed over that period of time. In other words, we took actual facts that happened as the seasonal and the cyclical and the wind variation and all the other factors, the ice variations in the winter time, we took all those factors into an actual computer analysis of historical facts, and we adjusted the flow every 6 months. We could adjust the flow much more frequently than that. But we in the Grand Canal business are expecting to sell two products essentially; well, I sup-

pose, three in a way. First of all, dependable water supplies, the water management system could not exist without dependable flood control. We intend to incorporate that into the system, and it was built into the computer analysis that we conducted. In addition to that, of course, we want to sell power, surplus power, because there is, during periods of high precipitation, no need to have the tap flowing. And yet you want to be able to give your power suppliers that are using acid rain type power generation in Canada and in the United States an opportunity to adjust their power production so they would be in keeping with our power surplus. We took all of those factors into consideration and we decided, for our analytical purposes, to do it on a six-month basis. I can show you the computer readout that was produced at that time and I think it will stand analysis. We were able to reduce a 5 feet, 7 inch variation from high to low without the Grand Canal to, I think, around 3 foot something, it was a reduction to just under 40%. These are facts which Mr. De Cooke might like to question. I'm very happy to have them open. We've taken them, by the way, down to Detroit to the Army Corps of Engineers some years ago, so they've had a chance to look at them again, and they are quite available here. I'd be happy to show them to him and I'm quite confident that they'll stand up.

*Mr. De Cooke:*
The one comment I would have, of course, is that, in defense of the qualified hydrologists that are currently working on the system and managing the system, we also use hindcast in the development of regulatory and management plans for the Great Lakes system. A good example, of course, is the regulatory plan for Lake Ontario use in hindcast and developing that plan—100 years of hydrologic records that went though 1954, satisfied the criteria for the development, as specified by the International Joint Commission for development. Less than 13 years after that plan was put into operation in 1973, that plan, despite all the forecasts that were made, exceeded the maximum level that was specified and developed in hindcast. What I am really saying, of course, is that because of the meteorological conditions and the climatic conditions which exist over the Great Lakes basin, once you put water into the system, you'd better have a way of getting it out very rapidly. We had that capability on the St. Lawrence River. We were not able to maintain the capability on the St. Lawrence River. We were not able to maintain the maximum level of the lake as specified by the I.J.C. This is the problem when you interject water into the system at the present time. The scheme is good. It should be studied. However, I feel we should learn to manage the resource we have before we bring addtional water into the system.

*Question:*
Tovell from Toronto. My friend here has suggest that we turn off taps for 10 hours. I think that some people here my remember the metropolitan form of government developed because taps did run dry up in North York.

*Moderator:*
Very good point. Turning taps off unfortunately causes a lot of concern at the local level, but doesn't really achieve what we want at the National or Regional level. Anybody from the panel would like to make a comment about what has been said this afternoon? Chad?

*Dr. Day:*
I'll make a general comment, one or two. To hear Tom's argument, it reminds me very much of an analogy that I heard out in the American west a few years back when I was living thre where the Americans wanted to create a human climate and so they went out and planted trees. They thought if you plant trees, this was back in the 1890s, if you plant trees it will create a human climate. I don't think that the analogies that Tom has drawn for water management in Holland and in China fit the conditions up in James Bay. And I think that's the first, the basic problem, that I see with his suggestions. Now, on the other side, as I listened to this plan, this is the first time I've actually heard it and I'm sorry that I haven't had time to read it before. It seems to me that this is a return to the thinking of the 1960s. That it's a physical problem, how do we build these things? If you look at the work of the Bureau of Reclamation, which you've heard about today, they saw irrigation as that kind of a problem. How do we build these facilities and they never ask the question will it pay? Bruce pointed out very clearly that they have not paid. And there's been a suggestion that the subsidies are maybe up to 90%. So, all of his plans are supply side, and I'd like to hear something about the demand side. When you are talking about jobs, what kind of jobs are being created, the assumption is that if we put more water into the Great Lakes basin, you're suddenly going to have more jobs. I don't think there is any deficiency of jobs in this region of Canada and the United States right now because of a lack of water. And I don't think supplying more water is going to create jobs. You'll have the same as they had in Churchill-Nelson and in James Bay, where you had up to 17,000 workers there for a year. But that is no long-term solution. The other thing is who would pay for the project? Would the jobs you create cost $500,000 or $5 million each because this is what you find in mega-projects? Those jobs are very, very costly. And, the last think if it's a matter of energy that Tom is talking about now, if you want any energy, go to Manitoba and Quebec.

They've just done two big diversions and they can't get rid of the stuff. If Ontario has any shortage of hydro-electricity, they should lock up long-term power at the present time, because you will get lower rates right now than you will get for the next half century or so.

*Moderator:*
Thank you very much. I think that puts the thing in proper perspective. There are a lot of issues here that can't be solved by engineers, and they've been accused of trying to build megabuck projects to get the economy rolling with a no good indication that environmentally or socially or economically they're sound. To be fair to the engineer, I think we do need an approach that's multi-disciplinary and, hopefully someday, it might even be interdisciplinary, that looks at these projects in a total national sense to see what their opportunites are and now we can approach them. I think the essence of what's come out of all that we've heard today is be prepared. Don't go on any longer without looking at the alternatives and deciding what alternatives would be appropriate, depending upon the conditions that may develop. Be prepared is a good slogan, I think to leave this session with.

I thank all the participants for their efforts.

# His Excellency, Mr. Paul Heron Robinson, Jr.

*U.S. Ambassador to Canada*

## Banquet Address

*An international businessman prior to his appointment in 1981, Ambassador Robinson headed a firm of specialist brokers in group insurance and mutual funds. Ambassador Robinson's ancestors on his father's side were Canadians. He is a graduate in Commerce and Business Administration (University of Illinois, 1953), and saw two years' service in the Korean War as an officer in the U.S. Navy, operating with destroyer units of the Royal Canadian Navy in Korean waters. During the last presidential election, he served as a member of the then Governor Reagan's Naval Advisory Committee*

It is a pleasure to be asked to speak, before so distinguished a gathering, about so important a topic. I accepted the invitation with alacrity, but also with some trepidation. Water issues are close to the hearts of many present tonight, and many more at home on both sides of the border. The range of opinion is wide. In accepting Premier Davis' invitation to speak, I have resolved to set myself a modest goal. It is to apply the light of common sense to these difficult Great Lakes water issues. Hopefully, this modest goal will enable me to avoid hostile fire from the many experts in the audience.

I would begin by reminding all here present that the U.S.-Canadian border is nearly as much water as land; more than 2,000 miles of boundary waters versus 3,000 miles of land border. Most of the boundary waters are found in the Great Lakes system, from Lake Superior to the St. Lawrence. The basin of these Great Lakes remains the heart of Canada and, indeed, still in many respects the heart of the United States.

We Americans and Canadians have shared these boundary waters for more than 200 years. The record of our joint stewardship is far from perfect, but it compares favourably with any similar border region anywhere in the world. We need each other if we are to deal sensibly with managing these great waters amidst the ever-increasing stresses of economic development and population growth. By and large, Americans and Canadians have realized this, and still do. I am confident that this record of co-operation will continue because there is no real alternative.

Specific issues will arise, as they have in the past, to test the skill of both governments or, perhaps I should say all of the many governments, including the provinces and states. Until they are resolved, such issues are termed problem areas. Afterwards, we congratulate ourselves on another example of co-operation in action. Co-operation, in short, need not be smooth sailing on a millpond. Often, the process can be as stormy as the Great Lakes themselves.

Two types of issues have historically troubled Great Lakes co-operation. Broadly speaking, they are water quality and water quantity. Although the primary focus of this Conference is on the latter, I believe balance requires some brief mention of the water quality record.

Pollution has existed since the first pioneer towns allowed their waste water to seep back into the lakes, since the first saw-mills and iron foundries were built. But the lakes are vast. Any problems of pollution concerned only those in the immediate vicinity of a source. The natural ecology of the lakes could process, absorb and eliminate the then-existing volume of pollutants. When people were few, and industries small, dilution could indeed be "the solution to pollution".

By the early twentieth century, economic growth had begun to outstrip the lakes' regenerative capacities. The issue of water quality was raised in the International Joint Commission only a few years after the signing of the 1909 Boundary Waters Treaty. Yet, for many years, the issue retained a fundamentally local flavour. A river or bay might receive attention, but the lakes themselves did not.

After World War II, the realization began to sink in that a broader approach was needed. The "downstream" lakes, Erie and Ontario, were under the greatest stress from untreated municipal and industrial wastes. Lake Erie became notorious. Most of those here tonight can probably remember, I know I can, the press accounts of the 1950s and 1960s that portrayed Lake Erie as North America's Dead Sea, an open-air septic tank in which only the lampreys and a few other hardy fish could survive.

Along with growing public outrage came improvements in the technologies of pollution control. The stage was set for progress. A catalyst was provided by the International Joint Commission. In 1964, both governments gave the I.J.C. a Reference to study Great Lakes pollution and suggest remedies. After exhaustive study, the Commission's 1970 report spelled out the damage that was occuring and recommended that the two governments agree to adopt water quality objectives, including programs for control of phosphorus and solid, shipping and hazardous wastes. The result of that I.J.C. report was the historic Great Lakes Water Quality Agreement of 1972.

The agreement was not reached easily. Our national philosophies toward pollution control sometimes differ. We share an interest in cleaner water, but may have good reasons for differing on how to attain that goal. We also became entangled in questions of principle, such as "equity versus equality" in assimilative capacity.

The agreement did not resolve the question definitely and, in various forms, it still troubles our discussions of Great Lakes issues. But we reached enough agreement to make progress possible.

The record since 1972 is not perfect, but the progress achieved is unquestioned. Municipal and industrial point sources have been brought under control. The I.J.C. has ably performed its role as monitor and watchdog of the agreement, through its various boards and its Windsor, Ontario office. Our continued joint dedication to improving water quality was exemplified in the 1978 renewal and expansion of the Great Lakes Agreement and in the supplementary agreement on phosphorus control, signed last November. These achievements required hard work. Besides the issue of equity versus equality in assimilative capacity, there were differences in national policies regarding effluent standards and the possible inclusion of tributary rivers. But the negotiators kept working until solutions were achieved.

Progress on what might be termed traditional pollution problems has allowed and encouraged greater interest in new areas of concern. Increasingly, the focus has shifted to non-point sources, which are particularly important for phosphorus; to toxic chemicals, fueled in part by improving scientific methods for detecting very small quantities; and to the possibilities of airborne deposition into the lakes.

These new concerns are legitimate. But we should not allow continuing problems to obscure the reality of co-operative achievements; the lakes are cleaner today than in 1972. Cleaner in terms of sewage and industrial waste, but also cleaner in terms of phosphorus and chemicals. The progress is real. The cost has been vast, but we have good reason to take pride in our common effort.

Bearing in mind this history of co-operation on water quality, I shall now turn to water quantity, including such issues as lake levels, diversions and consumptive uses. In doing so, I would ask my audience to bear in mind two points that stand out clearly from the record I have been discussing.

First, real problems are more likely to receive solutions. In other words, when politicians, industrial leaders, lobby groups and scientists clearly perceive a world problem, they become motivated to action. As a general matter, until the problem achieves such "real-world" status, many national, legal, local and bureaucratic obstacles tend to frustrate premature efforts to address them.

Second, progress is more easily achieved when we focus on specific, substantive issues. When we wander into the discussion of general principles, our differing national interests are emphasized and progress is frustrated.

The issue of Great Lakes water quantity first emerged through concern for lake levels. The Great Lakes are naturally self-regulating to a remarkable degree. Fluctuations are modest, compared to many other freshwater lakes. Both both nations have felt a need to improve on nature. Historically, lake levels have concerned:

- shoreline property interests, which favour a steady water level and fear, above all, high water;
- shipping interests, which want high water, especially during the summer season;
- hydro-electric power interests, which favour high water at all times.

In balancing these interests, the general policy has been to favour generally steady water levels within historic norms. Two of the lakes, Superior and Ontario, lend themselves readily to artificial regulation and have been regulated for many years, on a co-operative U.S.-Canadian basis. Their regulation under I.J.C. auspices, through the various advisory boards of control, is an essential part of the I.J.C. ongoing business.

The levels of the remaining lakes are not fully controlled, and are not likely to be so. The impetus for these studies came from high waters in the 1950s, and continued with low waters in the 1960s. The Commission ultimately concluded that full control of levels to even out such natural fluctuations would not be possible, except at costs that would exceed the benefits.

Our mutual inability to regulate, by engineering works, the natural fluctuations of lake levels encouraged greater awareness of the need to protect water levels from damage by those causes that are susceptible to human control, in particular, diversions and consumptive uses.

There are currently only two diversions of any significnce involving the Great Lakes. One is the Long Lac/Ogoki Diversion by Canada into Lake Superior, amounting to more than 5,000 cubic feet per second. The second is the Chicago Diversion, which takes 3,000 cfs out of Lake Michigan.

When diversions are mentioned in the context of regional water sharing, projects on the scale of the Long Lac/Ogoki and Chicago are meant. We do not mean diversions for domestic or sanitary uses, which are covered by an exemption in the 1909 Boundary Waters Treaty and which tend to be local and small-scale. We mean the contruction of large engineering works that would carry thousands of cfs of water to meet a need elsewhere, elsewhere being outside the Great Lakes basin and, in most scenarios, specifically the American High Plains of Southwest Regions.

This is what "regional water sharing" is concerned with. I can sum up the U.S. Federal perspective on such ideas very briefly. The United States Government believes that serious discussion of large-scale diversions is premature.

No adequate demand now exists for such diversions, nor any serious interest in supplying such demand, nor any source of funding for the immense costs of such ventures.

Because I recognize the sensitivity of water issues in Canada and the enduring concern of some Canadians that Canadian waters will be lost to the United States, I shall expand upon what I have just said. In essence, I am saying that Canada has nothing to fear from the United States on this issue of regional water sharing. Let me explain why.

It is unquestioned that a major diversion involving the boundary-water lakes would alter their levels, even if only by a few inches. Article 3 of the Boundary Waters Treaty gives the I.J.C. the power to approve or disapprove any such diversion. This means that the U.S. and Canadian sections must both agree. No such diversion, either into or out of the boundary waters, can take place except with I.J.C. approval, and the I.J.C. of course, is a binational institution.

There is one Great Lake that is not a boundary water, and hence is exempt from I.J.C. control under Article 3, Lake Michigan. But before worrying about unilateral U.S. action to pipe away Lake Michigan waters, study the record.

The only existing diversion from Lake Michigan, at Chicago, dates to 1848. Attempts to expand that diversion significantly in the 1930s and 1950s were repeatedly defeated by opposition from Canada, by U.S. states bordering the "downstream" lakes, and by cost considerations. In fact, the size of the Chicago Diversion has actually been reduced over time, from 4,200 cfs in 1909 to the current level of 3,200.

Further attempts to increase diversions from Lake Michigan are likely to meet the same fate, unless circumstances change so radically, at such a distant future time, that we as practical leaders in today's world cannot usefully speculate about them.

The high cost of capital would probably be enough to deter any large-scale, regional diversions of Great Lakes water, even without considering the other formidable obstacles. As a practical matter, in my personal judgement, any such diversions would require several preconditions:

- a pressing need for the water, one that could not be met any other way;
- a willingness on the part of the two national governments, but especially the U.S. Government to meet capital costs running into tens of billions of dollars. Certainly nothing smaller than a national government could do so;
- the active co-operation of Canada and all the affected Great Lakes states and provinces.

I do not see even one of these preconditions today, nor do I anticipate even one of them within the horizon of practical politics. This conclusion, I might add, is in line with that of the I.J.C. Board's report of 1983, which could envision no significant diversions within the period studied. I conclude from this that diversions do not deserve a high place on our agenda of U.S.-Canadian issues.

That same I.J.C. report also studied consumptive uses, an issue that is a little closer to practical concerns. The I.J.C. Board, created under a 1977 Reference, determined that rising consumptive uses could impact lake levels in the future. Making rather generous growth assumptions, the I.J.C. Board projected a possible increase in consumptive water uses from 5,000 cfs in 1975 to perhaps 36,000 in fifty years. This might translate into a maximum fall in the "unregulated" lakes of about 1 foot, or more likely less.

The result would scarcely constitute a disaster, and would moreover come with decades of warning. Nonetheless, the economic impact would be considerable, and the prospect has aroused concern on both sides of the border. The United States has responded by suggesting, in a note dated April 3, 1984, that we hold diplomatic consultations on the issue of consumptive uses.

The purpose of those talks would be to exchange data on the real dimensions of the potential problem, something very much in doubt, and to establish an early-warning system to spot worrisome trends. A continuing role for the I.J.C. would certainly be considered.

There is no reason to rush on this issue, and good reason to be careful. "Remedies" for consumptive water use usually mean conservation. For example, power plans can use "dry" cooling towers rather than using lake water. But a price must be paid in terms of electrical generating efficiency. We would not want to saddle U.S. and Canadian customers with that price, only to discover later that our growth assumptions were in error and our conservation unnecessary.

The United States Government looks forward to working pragmatically and co-operatively with Canada to define the limits of the consumptive use issue and eventually the solutions if the situation warrants. The process is apt to be lengthy, but the potential problem is so far removed that it permits us the luxury of time to deal with it.

If and when regional water sharing becomes a live issue, the United States Government will be prepared to discuss this also, and to manage the issue with Canada in a spirit of mutual inter-dependence. Building upon our long experience in Great Lakes issues, I believe such discussions will be most useful if we focus on the timely resolution of real problems, by pragmatic steps, after first carefully defining the nature of the problems. This approach, rather than debating abstract principles to guide hypothetical problems, is the way to progress. Both nations have cause for pride in our history of Great Lakes co-operation, and I am absolutely confident that this co-operation will remian a permanent characteristic of our relations as neighbours. Thank you.

**Pamela G. Wiley,**
*Executive Director,*
*Council of Great Lakes Governors*

# The Value and Use of Water Resources, Now And In The Future

*Ms. Wiley was appointed Executive Director of the Council of Great Lakes Governors in November 1983. Prior to her appointment, she was employed as lead analyst for economic development with the Division of State Executive Budget and Planning in the Wisconsin Department of Administration. Ms. Wiley was Assistant Director of the Wisconsin Farmland Preservation Program from 1978 through 1983, and served concurrently as legislative liaison for the Wisconsin Department of Agriculture, Trade and Consumer Protection between 1981 and 1983.*

*Ms. Wiley holds a B.A. Degree in Geography from the University of Maryland, and an M.S. Degree in Urban and Regional Planning from the University of Wisconsin.*

Welcome to this morning's panel discussion. It is the final formal session of the Ontario Water Resources Conference. My name is Pam Wiley; I am the Executive Director of the Council of Great Lakes Governors. For those of you not familiar with the organization, the Council is a private, non-profit corporation created in 1982 to provide a permanent forum through which the Governors of the Great Lakes states of Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin can work together on matters of common concern to the region. We consider the provinces of Ontario and Quebec to be associate members of the Council, and Premier Davis has been an active participant in Council affairs since the organization was formed.

The first major gathering of the Council took place two years ago, in June 1982, at the Mackinac Island Water Summit. That meeting involved all of the current Council states except Ohio, which joined the organization last March.

The Council's permanent offices are located in Madison, Wisconsin. Wisconsin Governor Anthony Earl is the current Chairman of the Council. Governor Earl was invited to participate in this Conference, and would have been here had he not already been scheduled to go on a trade mission to China. He asked that I convey his personal regards to Premier Davis and the Conference participants, and he wishes for a successful discussion of an issue which is certainly close to his heart and uppermost on the agenda of The Council of Great Lakes Governors.

I also want to take this opportunity to thank our hosts in the government of Ontario for their hospitality, and commend them for organizing what has been, and promises to continue to be this morning, a stimulating and thought-provoking discussion of the Great Lakes water quantity issue.

The theme of this morning's panel is "The Present and Future Value and Use of the Great Lakes Water Resources". The Conference organizers have assembled five distinguished speakers, each of whom represents a particular interest or point of view regarding the economic, social and environmental value of the Great Lakes system, to share their insights with us.

Before I introduce our panelists, I though it would be appropriate to put the question of the value of the Great Lakes into some larger context, and to comment on how that theme relates to the protection of the Great Lakes resources. One assumption underlying this panel and, to some extent, this Conference is that the present-day value of the Great Lakes water resource accrues primarily to users in the region, while its future value is to potential users both *inside* and *outside* the Great Lakes system. The concern expressed by the Great Lakes Governors and Premiers is to protect the system first and foremost for current and future needs in the region, and to avoid the exportation of the resource and the money and jobs it creates to other regions of our two countries.

Several other speakers have mentioned the Mackinac Island Resolution in which the Great Lakes Governors and Premiers made clear their opposition to transporting water out of the region. That Resolution was reiterated and amplified last November in Indianapolis, where the Council adopted a second Resolution related to water diversion. The Indianapolis Resolution did three things. First, it expressed the Governors' support for federal diversion legislation. Second, it called on each state to adopt state legislation prohibiting diversions of Great Lakes water for use outside their state without the consent of the other Great Lakes states and the International Joint Commission. Third, it created a Task Force on Great Lakes Water Diversion. The purpose of that Task Force is to evaluate the existing Great Lakes Compact and other institutional mechanisms to determine their relative abilities to strengthen the position of the states and provinces in resisting or regulating diversions of Great Lakes water.

The Task Force is made up of one representative of each Great Lakes state and the Canadian provinces of Ontario and Quebec. It is scheduled to make recommendations to the Great Lakes Governors and Premiers by the end of this calendar year. The Task Force has met twice now to discuss the relative merits of federal, state, provincial, interstate and international mechanisms to address the diversion question.

The challenge to the Task Force and to all concerned about Great Lakes water quantity is formidable. It has already become apparent to the Task Force that the only legal mechanism which would allow the states to *ban* diversions of Great Lakes water out of the region is federal legislation. The U.S. Supreme Court has determined that water is an article of commerce, which gives Congress the power, under the Commerce Clause of the Constitution, to regulate its use. The states are pursuing that option, and there is legislation pending before Congress which would effectuate such a ban.

Without federal legislation, the states and provinces have other tools at their disposal. However, their actions are circumscribed by recent U.S. Supreme Court and federal District Court decisions (the El Paso and Sporhase cases we have already heard about) which essentially bar states from interfering with interstate water transport unless:

(1) the state is protecting the health of its citizens and not just the health of its economy;
(2) the regulatory scheme is justified by a shortage of water available to citizens of the state; and
(3) regulations are narrowly tailored to protecting the water supply for the citizens of the state.

Moreover, the courts have indicated that the state must demonstrate its concern and commitment through a conservation and management program which applies equally to domestic and out-of-state users. (On the U.S. side, Illinois and Minnesota have programs in place which address these conservation and management needs).

Based on these legal limitations, the Task Force has come to the conclusion that simple state bans on water diversion, while useful in their message, would almost certainly be struck down as unconstitutional if challenged. It is clear that, in order to deal with the diversion question from an institutional standpoint as states, it will be necessary to consider the present and future value and use of the resource by the region. That legal necessity is, of course, buttressed by the regional water demand and consumptive uses forecasts of the International Joint Commission Diversion and Consumptive Uses Study Board.

What kind of context do these experiences provide for our panelists' discussions of the value and the use of the Great Lakes water resource? First, with respect to other regions' "value and use" of the Great Lakes, we cannot dismiss the possibility that some day there will be a serious proposal to transfer Great Lakes water to other regions. The current observations of westerners, i.e., that large-scale transcontinental water transfers are not economically feasible, reflect the present situation and fail to account for future uncertainties. The value of water will go up as it becomes more scarce in growing regions, and the cost of transporting it may well fall with advances in technology. On the U.S. side, the political base of the Great Lakes is eroding and, if current population trends continue, we are likely to lose a significant number of Congressional seats to the south and west by the end of this decade. The Council of the Great Lakes Governors is convinced that the states and provinces must "hedge their bets" with respect to inter-regional transfers, and the formal actions taken by the Governors and Premiers at Mackinac, and again last November in Indianapolis, strongly reflect that conviction.

Second, even if a serious diversion proposal from outside the region never materializes, we have good cause for concern within the region. The 1981 report of the International Joint Commission's Diversion and Consumptive Uses Study Board forecasts a substantial future increase in the consumptive use of Great Lakes water by the Great Lakes states and provinces. Over a period of years, the cumulative economic and environmental impacts of many separate consumptive uses will be the same as those caused by separate large-scale diversions.

Finally, the prospect of large-scale water diversions from the Great Lakes, whether a real threat or a mere hobgoblin on the horizon, has become a rallying cry for the lakes, and one which the Great Lakes Governors and Premiers clearly believe is long overdue. It has forced us to look hard at the economic, social and environmental value of the lakes and to evaluate our own present and future use and value of the water resource. That evaluation has led to the recognition that we in the Great Lakes states and provinces have some homework to do if we intend to protect the resource for our own future needs.

The speakers on this panel bring an important message to the Conference. In an era of fiscal constraints and interest group politics, it will be difficult to secure the financial resources and maintain the political commitments needed to protect the lakes. We must be careful and thoughtful in our arguments, and armed with sound facts and figures as we take our case to Washington and Ottawa and the state and provincial capitals. The information and perspectives brought to this Conference by the panelists will help us establish the essential factual base for the challenge which lies ahead.

We are fortunate to have United States Senator Dave Durenberger with us to provide a perspective on water policy in the '80s. We will also hear about three different aspects of the lakes' role in our regional economy. Thomas Gibson will talk about the lakes as a magnet to recreation and tourism, Gerry McIntyre will review the existing and potential economic value of the lakes as a source of hydroelectric power, and Rear Admiral Robert W. Timbrell will speak to the importance of the Great Lakes system to the commercial shipping industry. Finally, William Andrews will provide an analysis of the possible environmental consequences of water transfer proposals.

# U.S. Senator Dave Durenberger

*Minnesota*

## Water Policy in the '80s

*A graduate from St. John's University, Collegeville, Minnesota, Senator Durenberger received his Juris Doctor degree from the Minnesota Law School in 1959. Following seven years of law practice, he left to become Chief of Staff to Minnesota Governor Harold Levander. From 1971 to 1978 he was counsel for legal and community affairs and corporate secretary for the H.B. Fuller Company. Elected to the U.S. Senate in 1978, he has served as Chairman, President or Vice-Chairman of more than 15 major state or regional commissions. He has been especially active in open space conservation and environmental concerns.*

Each time I give a speech like this, we have a little contest in my office to see who can write the most creative title. Headlines, after all, are half the art in politics.

The winner for my talk this morning is, "Great Lakes Water Consumption and Diversion: Drinking Canada Dry." My task is to convince you that there are some in Congress who are sensitive to these issues and that, although we enjoy the soda, it is not our intention to make the brand name synonomous with U.S. government water policy.

A rational person looking at the question of water diversion from the Great Lakes might conclude that there is little cause for concern. There are many reasons to doubt the prospects for any large-scale diversion of water from the Great Lakes basin.

First, the Lakes are an important economic asset to the states and provinces which surround them. Recreation, tourism, transportation, bulk cargo shipping and industrial and drinking water supplies are the economic life blood of these states and provinces. Minister Alan Pope is particularly convincing when he details the economic harm that would result from potential diversions. A rational person would have a hard time believing that any of the border states would approve schemes that did direct damage to their economies.

Because of their economic importance to the region, the Lakes have been protected by a series of legal and diplomatic steps at the state, regional, federal and international level. Some states and the Province of Ontario have taken strong positions to oppose diversion. Regional compacts have pledged solidarity on the issue. The U.S. Supreme Court has kept a lid on the size of the Illinois and Michigan canal diversion at Chicago. And Canada and the United States observe a treaty which requires joint approval of diversions from boundary waters.

A further roadblock to the schemes of those in arid regions who thirst for our waters is cost. The one detailed study on a diversion from the west end of Lake Superior to the Missouri River basin estimated the cost of a 10,000 cfs (cubic feet per second) diversion at $26.6 billion. Beyond the pale of economic rationality, most would conclude.

So why worry? Looking at the political, legal, diplomatic and economic problems that any diversion project would have to overcome, the rational person might think that the concerns which prompted this conference are misplaced.

But, but the first principle of water policy, in my country, at least, is that rational thinking doesn't apply.

Look at the Garrison Diversion project, for instance. It is designed to irrigate 250,000 acres of farmland in North Dakota. At a cost of $1.3 billion, that is a $5,000 per acre cost of capital for agricultural land that has a substantially lower market value, even after irrigation.

The farmers who will benefit from Garrison grow wheat, an important factor in balancing U.S. trade deficits. No doubt irrigation from Garrison will greatly increase their yield. But last year the U.S. government gave them wheat through the PIK program to take their land out of production.

Over-production of agricultural commodities cost the U.S. government $27 billion in price supports and PIK distributions last year, and over-production will continue to have a depressing effect on our farm economy for some time to come. So, I ask you, how do we explain to the rational person the billions of dollars we spend each year to irrigate marginal prairie lands?

Garrison is a typical example of U.S. water policy. Cost has been no barrier. Economic rationality is not a consideration. Water is a political, not an economic, commodity. Everybody else got a piece of the Missouri, so North Dakota is entitled to its piece, too. Regardless of the cost or environmental consequences of this interbasin transfer.

What about the legal barriers? There are, I think, two significant loopholes in the legal and diplomatic protections that have been built up around the Great Lakes.

Minister Pope has referred to one of them as the Great Lakes "wild card." Lake Michigan lies entirely within the United States and is thus not subject to the protections of the Boundary Water Treaty and other agreements between our national governments. The Chicago Diversion from Lake Michigan to the Illinois River and thus to the Mississippi basin is rightly viewed as a "wild card" in an otherwise tight system of legal protections.

The Mississippi is a potential source to recharge the Ogallala Aquifer, an immense groundwater resource underlying 13 states in our agricultural heartland that is being rapidly depleted through intensive farming. 200,000 wells tap the Ogallala to irrigate 26 million acres of farmland.

Because the water tables have dropped substantially in some portions of the aquifer, Ogallala politicians are beginning to look for future water supplies. The United States House of Representatives has passed a bill, H.R. 71, authorizing the Federal government to determine whether the aquifer might be recharged by pumping water *into* the ground through high-pressure injection wells.

Although it is only a small demonstration project at this point, one can envision a massive new public works program with the U.S. government recharging the aquifer by injection wells at one point so it can be depleted by an irrigation well at some distant location. We've diverted great rivers, created great reservoirs, so I can easily imagine an attempt to replenish great aquifers. But where would the water come from? The question hasn't been answered, but interbasin transfers would be necessary and the Mississippi basin has high potential, particularly if it can be replenished by diversions from Lake Michigan through Chicago and the Illinois River.

Today, the Chicago diversion is regulated at 3,200 cfs (cubic feet per second) by a 1967 decision of the U.S. Supreme Court. But is has capacity for diversion at more than double that rate. It's the "wild card".

Mention of the Supreme Court brings us to the second loophole in the legal protections that we are relying upon to protect the Great Lakes. Two recent decisions of the Court should give even a skeptic cause for concern.

One was a water decision. For most of our history, our courts have held that water is not a commodity in commerce. It wasn't possible to own it privately. It was a resource belonging to the states. Under that theory, the state of Nebraska enacted a statute that prohibited the export of water to another state that did not reciprocate with exports of its own. In the case, *Sporhase v. Nebraska*, the U.S. Supreme Court struck down the Nebraska statute as an impermissible burden on inter-state commerce. Nebraska no longer owns its water.

In a related opinion, the Court found that the need of a Texas city for drinking water was sufficient to override a New Mexico law prohibiting the export of precious groundwater across the border. The City of El Paso, Texas, now has municipal drinking water wells in New Mexico with the Court's blessing.

As a result of the *Sporhase* and *El Paso* decisions, one has to ask whether the laws of the individual Great Lakes states, or even their determined resolution in a compact of several states, would be able to prevent a privately-organized diversion of Great Lakes waters to meet the needs of some far off region.

And a second decision of the Court raises the possibility that one or more states would actively co-operate in a diversion despite the economic and recreational consequences to the Lake system. The case was *Commonwealth Edison v. Montana*. The resource was not water, but coal. Montana imposes a 30% severance tax on coal extracted from Montana mines. Most of the coal is on land owned by the Federal government. The revenues from the tax far exceed any impact that mining has on Montana. In fact, the dollars are put into a trust fund and the interest is used to pay the cost of general government: keeping other taxes low.

Despite the fact that the coal belongs to the Federal government, despite the extraordinary rate of the tax, and despite the fact that the tax is exported to citizens in other states, the U.S. Supreme Court found no reason to object. Imagine the kind of tax relief that a Great Lakes politician could offer if he could finance tax cuts with a severance tax on fresh water diverted from the Lakes to some arid state in the West. Just such an offer for water from the Oahe Reservoir has made William Janklow the most popular governor in South Dakota history.

So, cost is not a problem. The legal protections are precarious. The potential for greed to divide us is plentiful. Yes, diversions are a very real threat to the future of our Great Lakes.

What to do about it? Some have suggested that we seek amendments to the Boundary Water Treaty to include Lake Michigan diversions within its scope. I think that an unlikely step for the United States Government to take.

Many states have or will act to tighten protections. But given the recent decisions of the Supreme Court, I doubt the efficacy of state action, even of the states acting together.

There are bills pending in the Congress which offer possibilities. In particular, Senator Percy of Illinois has introduced S. 2026 which follows a resolution of the Council of Great Lakes Governors. That bill would prohibit the diversion of waters outside the region without the express consent of each of the Great Lakes States and the International Joint Commission. It would also prevent studies of various diversion schemes financed by U.S. Government agencies. It's a good bill and we should seek its early adoption.

But the real issue here is deeper. It's the question we started with. How much longer will we tolerate a water policy that requires us to abandon our good sense as a prerequisite to being involved?

History, both U.S. and Canadian, suggests that question may not have an answer. But some of us are trying to make a new start. I am Co-Chairman of an organization called the National Water Alliance founded by members of the House and the Senate. The Alliance has an ambitious charter, to educate, to provide forums for discussion, and to seek consensus among broad segments of the American public on fundamental issues of water policy. In addition to Senators and Congressmen, the board of the Alliance includes leaders from industry, the labor unions, environmental organizations, state and local governments and water suppliers and users.

The various parts of American government are intensely divided on water policy issues. In the Congress, budget committees disagree with public works committees on how water projects should be funded. Across branches at the Federal level, there is no agreement on which projects are of high priority. And up and down our federal system each layer of government is trying to shift the costs of water decisions, both supply and quality decisions, onto some other layer of government.

It is the hope of the National Water Alliance that by going outside of government, by getting away from the notion that water is a political commodity, we can find some good sense. At this stage, the Alliance is hosting a series of discussions across the U.S. Perhaps some of you have had a chance to participate in one of those forums. Minister Pope spoke at a recent conference in St. Paul, Minnesota. All of you, Canadian and American, are invited to lend your expertise in the future.

With the hope that efforts like the Alliance and this conference can improve the water policy process in the future, let me return to the Great Lakes and conclude with a few comments on the consumptive uses, water taken out of the Basin and not returned.

Most of the concern I have seen expressed about consumptive use is based on a single study by the Great Lakes Diversion and Consumptive Uses Study Board, presented to the International Joint Commission in 1981. If that study is accurate, consumption would appear to be a greater problem than diversion as we look into the future. The study estimates that consumption will increase six fold by the year 2035, fifty years out. That level of consumption would reduce the outflow of the St. Lawrence Seaway by 8 1/2%.

Although I have not had an opportunity to review the detailed appendices of that study, I would be reluctant to make sweeping public choices on the basis of these projections. Most of the estimated increase is in the industrial sector. In fact, industrial consumption would grow from 51% to 87% of total uses. Perhaps that's very good news. All of our constituents will be glad to know of the industrial boom that's just around the corner for the Great Lakes region.

But when you look at the figures closely, doubt creeps in. Most of the increased consumption in the industrial sector is for electric power plants. When this study was drafted, the power industry was projecting rapid growth, year-after-year, as far out as one could see. But several American electric utilities are now near bankruptcy because they made investment decisions based on those demand projections. It appears there will not be hundreds of nuclear power plants with closed-cycle cooling systems dotting the Great Lakes region in the year 2035. Growth in electric power consumption is not anywhere near the 7% annual increase we experienced in the 1970s.

To bring this question into clearer focus, some have suggested that consumptive uses be raised as a reference item to the International Joint Commission. Speaking for myself, I don't think we are at that point yet. After all, if we looked back fifty years to 1935, nuclear power generating stations would have been no part of anyone's expectations. Jumping to conclusions based on one picture of the world fifty years out seems to me a little hasty.

Rather than seek an official international projection at this time, I would prefer to see the many federal, state, and provincial governments authorize studies using several assumptions and methodologies. We need a much broader base of understanding before we turn this issue in a policy-making direction.

If you look at the human landscape of this region of North America, you realize that it is a living testament to the bounty of the Great Lakes as a natural resource. They satisfy both our need for a living and our spirit for life.

Although largely non-renewable and often abused, the Lakes remain the great resource of our region. We are doing much to protect their quality. Real improvements are noticeable as a result of the Water Quality Agreements of 1972 and 1978. We have a way to go on non-point sources, toxic contaminants and pollution deposited from the air. But there is reason to boast and be hopeful about the quality of our water.

In the same way, I would sound a hopeful note on the quantity side, as well. We need to act together and act now to prevent diversions. That sensible people will join together in conferences like this to share concerns *is* a very good sign.

As to consumption in *our* region for the benefit of *our* region, it is not time to ask EPA or Environment Canada to develop artificial controls on water uses. Water is our bounty. We ought not waste it. But it's the economic commodity that does the work on this part of the continent. Let us not rush to deny the benefits of this bounty on evidence too slim or jealousies exaggerated. As they were the foundation of our past, the Great Lakes are the promise of our future.

Thank you, ladies and gentlemen.

## T.H. Gibson

*Deputy Minister,*
*Ministry of Tourism and Recreation*

# Water—The Magnet for Tourism and Outdoor Recreation

*Following a career in packaged goods and financial service industries in the private sector, Mr. Gibson joined the Ontario Government as Director of Tourism Advertising, Department of Tourism and Information in 1971, eventually becoming Executive Director of Tourism and Marketing. In 1982, he became General Manager of Ontario Place, a position he held until his appointment as Deputy Minister of Tourism and Recreation in 1984.*

My topic today is the relationship of water to the tourism and recreation industries in Ontario.

In particular, I have been asked to give the tourism perspective on a frightening possibility. That is the reduction in the quantity of water in our Great Lakes, particularly in the lower lakes. The scientists have established that we are taking more water from these lakes than precipitation is returning.

At the current rate of increase in consumption, we could be facing lakes that are lower by 12 to 34 centimetres in the next 50 years. Even more alarming, there is discussion of diversion of water from the Great Lakes, diversions that could reduce water levels by even greater amounts.

In Ontario, water is elemental to both tourism and recreation. I've chosen to discuss this in terms of:

- the growing importance of the Great Lakes;
- the possible effects of massive water diversions on our north;
- and the close relationship of water, tourism and recreation with the quality of life in Ontario.

First, I want to impress you with the importance of the tourism and recreation industries. Some of you may still equate tourism and recreation with fun and games.

That's not entirely wrong, but I'd like you to know that tourism alone is the second largest industry in Ontario. Only the automobile industry generates more export dollars.

Some people tend to overlook the importance of tourism as an industry because the plant isn't obvious to them. In fact, the industry has a huge plant. But it's not concentrated in two or three locations, so its enormous size is not evident.

The tourism industry's plant is literally everywhere and, I might add, in many cases dependant on water resources.

In 1982, Ontario's $6.3 billion tourism industry generated a total of $7.9 billion in total income, about 6 per cent of the gross provincial product. That spending produced more than 361,000 person-years of direct and indirect employment. That begins to give you some idea of how important Ontario's tourism industry already is.

I said "already" because tourism is just getting started as an industry. Tourism isn't even in its adolescence yet. Tourism is the industry of the future.

This is a "futures" conference. I want to impress you with the importance of water to what will be Ontario's most important industry of the future.

Twenty years ago, if you stood where this hotel is, you would have seen something very different. You would have been surrounded by heavy industry, by freighters loading or unloading. In short, you would be viewing what we all would consider a traditional industrial port.

That's not all gone now. But you have to look to find it. We've opened up the waterfront to the people, the tourism and recreation industries.

Now you'll see sailboats, more and more of them every year, along the lakefront. The old recreation areas are still there, and changing rapidly as they introduce contemporary attractions.

The forerunner of Toronto's waterfront development, Ontario Place, one of the largest theme parks in the world, draws 2 1/2 million people every year.

Harbourfront, a complex of renovated industrial buildings, now provides cultural activities, educational programs, the lively arts, even antique markets for people drawn to our waterfront.

Hotels, apartment buildings and other 'people places' have sprung up to replace the grain elevators that have disappeared.

Urban planners from other cities come here to study what's happened. They look to this city as a model as they begin to prepare for the post-industrial futures of their own waterfronts.

Is water a magnet for tourism and recreation? Try coming down here on a nice Saturday or Sunday afternoon. The answer will become obvious.

But take a tip from me. Park uptown if you plan to come to this location. I'm afraid you'll find that a large number of other people will have arrived ahead of you. In fact, you'll get here faster if you walk.

Every indication is that this trend to gravitate to the lakefront will continue and grow.

Municipalities along the Great Lakes seeking new industries have made tourism one of their first choices. In dollars and cents, the revenue from the tourism industry often more than compensates for the loss of revenue from declining industries.

Even more attractive, tourism is labour-intensive. It's an industry that provides work for people at a time when technology is reducing the need for workers in many other industries.

How do you relate water to tourism? Better to ask, how do you have a tourism industry without water?

I suppose you can. The two attractions that come first to mind are casinos and pyramids.

But that is not the basis for Ontario's tourism industry, either now or in the future.

The importance of water in Ontario's tourism is as important as water in the human body. It's critical.

The Great Lakes have always played an important part in Ontario tourism. Let me list some of the attractions on these lakes, attractions which represent significant investments in the tourism industry.

- We have 132 municipal, provincial and national parks with frontage on the Great Lakes.
- We also have 209 conservation areas in the watersheds of the Great Lakes basin that serve as regional recreation and tourism areas.
- Some of our special attractions for tourism, Ontario Place, the St. Lawrence Parks, the St. Clair Parkways and the Niagara Parks, all depend directly on the Great Lakes.
- For boaters, we have the Trent-Severn Waterway, the Rideau Canal, 300 marinas and the two best inland sail cruising areas in the world, the Thousand Islands and the North Channel.
- In recent years, the Great Lakes have provided spectacular fisheries for salmon and rainbow trout.

The renewed angling interest in the Great Lakes has a strong recreational component existing alongside the multi-million dollar charterboat fleet.

The resurgence of the Great Lakes fishery, particularly in the lower lakes, has made it possible for people who live near the lakes to walk down to the shoreline in the evening, knowing that they have a reasonable chance to tie into a spectacular game fish.

Angling is only one example of how recreation is tied to the water.

Our lakes and rivers have paddlers out pursuing their own recreation in everything from racing canoes and kayaks to giant war canoes.

Many water activities are highly organized sports that have a large number of participants and competitions at a provincial level. Fully 10% of the sports with provincial governing bodies are water-related.

Water skiing and boating are major forms of recreation along the Great Lakes. Ontarians own more than 1 1/2 million boats, and nearly a quarter million boats use the Trent-Severn waterway each year.

There's no doubt that reduced lake levels would diminish the value of all of these important tourism and recreation activities.

I shudder to imagine Ontario Place surrounded by mud flats, rainbow trout unable to get into the rivers to spawn, marinas stranded high and dry, or the thunder of Niagara Falls reduced to a dull roar.

That sounds a bit dramatic, but scientists have warned that, even with just increased consumption, let alone increased diversion of waters from the lakes, those things could happen.

The effect on our tourism industry and our recreation plant would be disastrous. The scope of the loss is difficult to predict or comprehend.

Consider the effect of just slightly lower lake levels on our wetlands and the resulting damage to our tourism and recreation.

Wetlands play a vital role in the life cycle of almost every species of fish in the Great Lakes. Diminish the wetlands and you threaten a multi-million dollar sport fishing industry.

Wetlands are vital to waterfowl, with the Great Lakes wetlands playing an especially significant role during spring and fall migrations.

It has been estimated that wetland-related activities produced more than 50 million user-days of fishing, hunting, camping and birdwatching. That contributed more than $800 million to our economy.

Our Great Lakes wetlands are clearly vital to both tourism and recreation. If we were to lose these areas because of the lakes dropping just a few feet, our patterns of recreation and tourism would change, and the effects of those changes would not be beneficial.

That's why I chose the analogy with the human body. You can't reduce human water levels and still have the body functioning the way it should. If you reduce the level of water in the Great Lakes, you are going to dramatically affect tourism and recreation.

Water, in short, is as vital to tourism as it is to people. That applies across this province, not just the areas near the Great Lakes.

It's already obvious that the issues raised by the discussion of removing water from the Great Lakes have implications that extend into other parts of the province.

At this Conference, I understand there are scenarios being discussed involving taking water from the Arctic watershed, the water flowing into James Bay and Hudson Bay, and diverting it into the Great Lakes.

That has already happened in Northwestern Ontario, where water from appreciable areas of the Arctic watershed were diverted during the 1940s.

But Northwestern Ontario is more than just a huge area that has vast quantities of water flowing directly into the salt of the Arctic Ocean.

Northwestern Ontario has people living there. And it has an important tourism industry.

Any plans that are made for Northwestern Ontario, or for the rest of Northern Ontario for that matter, will have to consider the interests of the population.

The tourism industry in Northern Ontario has nearly 5,000 separate establishments and is well represented by its principal advocacy association, the Northern Ontario Tourist Outfitters Association.

Tourism is, along with mining and timber extraction, one of the three principal industries of our north. In fact, the tourism industry in Northern Ontario employs nearly one-quarter of the people in the area.

We fully anticipate that is only the beginning, and that tourism will grow to be the largest single employer in the area. To allow that industry to grow, we must work to preserve the natural tourist attractions of the north.

Northern Ontario has more than just large quantities of water. With some exceptions, the quality of the water is unrivalled.

That means the fishing is excellent. There are populations of fish there that have been adapting to their environment ever since the ice receded in the last glaciation. Any changes to the rivers and the water flows in that area could upset a balance of nature that has existed for thousands of years.

Even more important, the north has wilderness, the very thing the rest of the world is running out of. That wilderness was once almost inaccessible to the urban tourist. Only in the past few decades have float planes opened up the area.

Every passing day, Northern Ontario looks closer and more accessible. People are beginning to recognize the area for what it really is, a wilderness in the epicentre of the North American continent.

In tourism, we look to the north as an important part of our future. The area is already attracting large numbers of European tourists. The tourism industry there is water-based. Any plans for water diversions in that area of the province would have to be subject to the scrutiny and approval of both the people of the area and the tourism industry there.

The quality of life in this province is both one of our tourist attractions and one of the benefits we get from having a tourism industry.

Again, Toronto is a good illustration of the point. It is just one of many large urban areas along the Great Lakes. What sets it apart is the quality of life in the city.

That quality is, in part, a result of good fortune. We have a good location, and natural beauty around us. But another part of that quality of life is something we pay for.

Our society pays for clean streets, well-run municipal governments, the social services that keep our population healthy and happy.

When people talk about proposals that would make our goods more expensive or our electricity more difficult to acquire, they are talking about chipping away at our quality of life. They will make us less able to afford to maintain our services.

In many other parts of Ontario, it's only the water-based tourism industry that makes it possible for smaller communities to have the quality of life they enjoy.

There are remote parts of the province where you will find recreational and cultural attractions that people living in the area would never be able to support. They have those things to enjoy because of the dollars the tourism industry brings to their area. This enhances their quality of life.

When you talk about proposals that would diminish the tourism industry by depriving it of the water essential to it, you are talking about a direct reduction in the quality of life and the recreational opportunities enjoyed in many small communities.

In the recreation industry, we are dealing with a social fabric that is changing rapidly. There are demographic changes as our population grows older and people choose to live in different places.

Even more important, there are changes in attitude, in the work ethic, and in the workplace itself. The amount of leisure time available to people is increasing, sometimes voluntarily as people choose to work fewer hours, sometimes involuntarily as technological changes reduce the need for workers.

We need to plan for recreation, plan for the additional leisure time that people will have available to them. Water will play a critical part in any creative solutions to providing North Americans of the year 2000 with full and satisfying recreational pastimes.

As the advocate for tourism and recreation, it's our job to anticipate the needs of the tourism and recreation industries. We must work to ensure that the resources that tourism will need are not debased, and that our people will have adequate high-quality recreational opportunities in the future.

That means my Ministry will have an important role to play in any negotiations regarding our water. Anything that happens to reduce the quantity of water in the Great Lakes will affect the potential of our tourism industry and our recreational plant.

I'm confident that the Ontario government will continue to support the industries of tourism and recreation. And I'm also certain that the people of this province will support the conservation of the water in the Great Lakes.

Twenty years ago, when we were faced with the fact that we had damaged the water quality of the lower lakes, we acted. The people of this province supported our efforts to rehabilitate the lakes.

Perhaps the motivating force at that time was negative. We were simply ashamed of what we had done to our lakes.

That translated into the will to pay the cost of repairing the damage. All across this province, people dug deep into their pockets to pay for better sewage treatment.

Municipal councillors bit the bullet and added sewage treatment costs to tax bills. In some places, they had to turn away industries that wanted to locate in their areas, simply because their sewage treatment systems couldn't handle that industry.

The problems are far from solved, but we have made progress. Today, people are reaping the benefits of their early investments. The lakes are once again an appealing recreation area for our own citizens, a magnet for tourists in Ontario.

It's obvious that people are re-focusing their attention on the Great Lakes for tourism and recreation.

All of us are aware that there are problems coming in terms of quantity of water.

Perhaps in dealing with problems of water quality, those of us who live around the lakes have become much more aware of the vital importance of water quality *and* water quantity. Both are essential to tourism and recreation, our major industries of the future.

It's obvious at this Conference that we are on a collision course. Some of us are counting on water for future industries. Others here are running short of the water they know they will need for their economies. Everyone is looking to the Great Lakes to solve some of their problems.

People who are looking to the Great Lakes as a source of fresh water are posing solutions taht would threaten the future of future of recreational facilities, our tourism industry and our quality of life.

That doesn't mean we have nothing to offer. We have been dealing, rather successfully, with massive problems involving water. In a co-operative effort that involved every level of government in two countries, we have made progress on water quality. I hope that those people who are anticipating water problems can learn from our experience.

Our experience is a resource that you can feel free to tap at will, to our mutual benefit.

Thank you.

## G. F. McIntyre
*Director of the Corporate Power System, Programming Division*
*Ontario Hydro*

# Water—Existing and Possible Future Economic Value For Hydro-Electric Generation

*Mr. McIntyre graduated from the University of Toronto in 1965 with a M.A.Sc. in Electrical Engineering. He joined the System Planning Division of Ontario Hydro in 1964 and remained there until 1983. In the System Planning Division, Mr. McIntyre was responsible for formulating and recommending plans for the development of the future generating resources of the Ontario Hydro system. Since 1983, he has held his current position as the Director of Hydro's Corporate Planning Group.*

I have been asked to describe the existing and possible future economic value of the Great Lakes waters for hydro-electric generation, so that you can appreciate the magnitude of electricity use in this province, I will take a few moments to describe Ontario Hydro.

Ontario Hydro is a Crown Corporation. More precisely, it is a special statutory corporation of the Province of Ontario which was established in 1906 to generate, supply and deliver electric power throughout the province.

In size, capability and organizational strength, Ontario Hydro is comparable to the Central Electricity Generating Board in Great Britain or the Tennessee Valley Authority in the United States. Its capital investment in plant, stations and other equipment is about 23 billion dollars, while its annual revenue is currently in the order of 4 billion dollars.

To describe the magnitude of electricity usage within the province, I will use a unit of measure called the megawatt which is 1,000 times the size of the kilowatt. You are probably more familiar with kilowatts as your power bill is based on kilowatts and hours. The peak electricity demand by Ontario Hydro's customers this past winter totalled 19,000 megawatts. This demand was met by almost equal contributions from nuclear, coal-fired thermal and hydro-electric stations.

The hydro-electric portion was generated by 68 hydraulic plants with a total capacity slightly over 6,500 megawatts. To put this into perspective, our hydraulic system can supply the peak electricity requirements of almost two Metropolitan Torontos.

You can quickly appreciate that one of the characteristics of the hydro-electric system in Ontario is its geographical diversity (Figure 1). Rather than large units concentrated in central stations, which is the case for thermal generation, you find many units of various sizes located where nature has supplied sufficient water volume and a concentrated fall in elevation.

Our 68 stations include 265 turbine-generator units ranging in size from less than 1 megawatt to 130 megawatts. The stations therefore range from the 1,900 megawatt Sir Adam Beck complex at Niagara Falls with 32 units (Figure 2), down to the single unit of 145 kilowatts at the Wasdell Falls Mini Hydro station (Figure 3).

In addition to these publicly-owned stations, there are about 100 privately owned stations which have a combined additional capacity of near 650 megawatts. The total available hydraulic capacity in the province is, therefore, close to 7,150 megawatts. The Ontario Hydro stations which use Great Lakes waters contribute 2,660 megawatts or 37 per cent of this total. In using this water we comply with all federal and provincial legislation and various international agreements.

Of course, when considering the Great Lake waters for electric power generation, you must also include Ontario's neighbours, the province of Quebec and the state of New York (Figure 4). They also have hydro-electric resources which utilize this water. In the case of Quebec, they have developed sites on the St. Lawrence River where the river is entirely within Canadian boundaries and so utilize the entire flow. Between Lake St. Louis and Lake St. Francis, they have developed some 1,740 megawatts of capacity.

New York State, on the other hand, in a pattern similar to Ontario, has developed sites on international sections of the waterways because that is where the geography provided the potential. Their combined capacity at Lewiston on the Niagara River and at Messena on the St. Lawrence River totals some 3,100 megawatts. As a result, there have been nearly 7,500 megawatts of hydro-electric capacity installed which use the available flows through the Great Lakes system in Canada and the United States.

Up to now I have been using "megawatts" to describe the capability to produce power. Due to the wide variability in river flows through the year, and for other detailed technical and economic reasons, hydraulic plants are usually built with the capability to use more water than the average amount available in the river during the year. Therefore, simply measuring the "megawatts" of a hydraulic resource can be misleading. Another notion that must be introduced is the concept of energy production. This is usually expressed in megawatt hours. However, for convenience, we have also developed the term "average megawatts".

Ontario Hydro's total hydraulic capacity of 6,500 megawatts can be expected to produce about 4,000 average megawatts or about 62 per cent of its maximum capacity (Figure 5). However, because the water flow through this system is so dependable the 2,660 megawatt portion installed on the Great Lakes can be expected to produce a surprising 2,170 average megawatts or about 82 percent of its maximum capacity. Thus more than half of Hydro's hydraulic energy is produced by Great Lakes water.

The next question is how much are Ontario Hydro's hydraulic resources worth? Obviously, this is a very complex question, so I am going to limit it a little by confining my answer to the value to electricity customers as opposed to flood control, transportation recreation, etc. Also, I would not want you to think that hydraulic developments are free of environmental problems. They are not. But, here again for simplicity, I will not discuss such cost in any detail.

If Ontario Hydro were suddently without its 6,500 megawatts of hydraulic generation and it could somehow replace it with new coal-fired generation today, this would result in additional annual costs to Ontario of 1.4 billion dollars per year, measured in 1984 dollars (Figure 6). This includes the cost of fuel, operation and maintenance, plus the interest and depreciation on the capital costs. To meet these costs, electricity rates would have to be increased by about 30 per cent. The value of the Great Lakes stations is estimated to be about half of this or 700 million dollars annually. These annual costs would, of course, increase each year over time with escalation.

Another valuable aspect which should be taken into consideration is the environmental impact if alternative generation is used in place of hydraulic. For instance if we did not have this 6,500 megawatts of hydro-electric generation, we estimate producing the power at coal-fired stations would require the consumption of an additional 12 million metric tonnes of coal each year (Figure 7). It is not my intention today to express the cost of air pollution or acid rain in dollar terms, but clearly hydraulic generation vastly reduces the potential costs.

So far I have been taking a broad view in order to give you an appreciation of what hydraulic resources mean to Ontario electricity consumers. A more useful scenario might be to consider the economic effects of reducing the flow through the Great Lakes generation systems by 10,000 cubic feet per second. This is equivalent to approximately 5 per cent of the flow.

To understand what this means to utilities such as Ontario Hydro, you need to know a little bit about how they operate.

The objective of the system operators is to supply the customer's electricity demands reliably and at lowest cost. This means utilizing the resources with the lowest operating cost first, such as hydraulic, and adding successive higher cost units, nuclear, coal-fired, oil-fired, as necessary. A typical winter day is shown in Figure 8. In Ontario, a reduction in hydraulic energy would have to be made up by a corresponding increase in coal-fired energy.

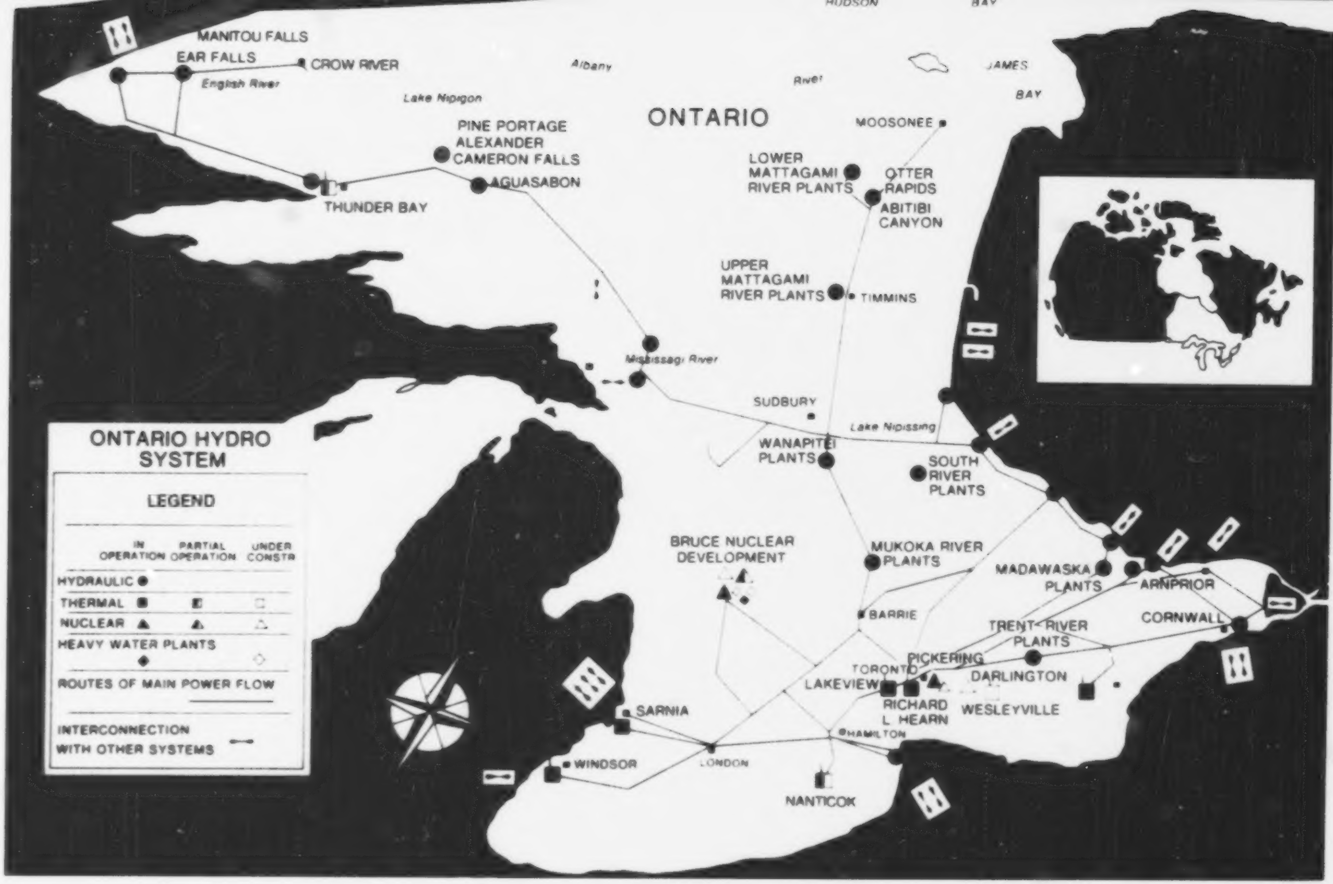
Assuming the 10,000 cubic feet per second flow reduction is shared between Canadian and American utilities, the cost for 1984 would be $20 million for Ontario Hydro, $80 million for New York and $15 million for Quebec (Figure 9). So, for each year it occurred, the effect of this reduction would be $115 million in today's dollars.

Up to now, I have been talking about the value of our hydraulic resources currently in place. But what about the future? Are there any major developments left in Ontario? The answer is yes. Although Hydro is heavily involved in bringing new nuclear generating units into service over the next 8 years, we must look further down the road at what the longer term electrical needs of Ontario might be.

Our thoughts are still very much in the conceptual state at this time, as current projections indicate we will have adequate resources until the late 1990s. Although no commitments of any kind have been made and many options have to be considered, we think additional major new hydraulic generation is possible in Ontario within the next 30 years. This could be about a 25 percent increase in our current hydraulic system.

One of the locations to be considered is further development at Niagara Falls. On the Canadian side, there are several generating stations that were built in the early 1900s. These stations are old and were designed to use water at about 30-50 per cent of the efficiency of the newer Sir Adam Beck and Lewiston plants. It may be possible that they could be replaced by a new development at Niagara.

The bottom line is this: several public utilities have invested hundreds of millions of dollars of public money in constructing hydro-electric developments which make the best use of the water resources of the Great Lakes. In turn, these investments help them provide a secure supply of economically-priced electricity. In our world today, this means a competitive edge in attracting industry, encouraging economic growth, and keeping our products competitive in world markets. It is, therefore, essential that the interests of the power consumers these utilities serve, both today and tomorrow, are fully considered before any changes are made to the Great Lakes waters.


ONTARIO HYDRO SYSTEM
LEGEND
IN OPERATION
PARTIAL OPERATION
UNDER CONSTR
HYDRAULIC ●
THERMAL ■
NUCLEAR ▲
HEAVY WATER PLANTS ◆ ◇
ROUTES OF MAIN POWER FLOW
INTERCONNECTION WITH OTHER SYSTEMS
ONTARIO
HUDSON
BAY
JAMES
BAY
Albany
River
MANITOU FALLS
EAR FALLS
CROW RIVER
English River
Lake Nipigon
PINE PORTAGE
ALEXANDER
CAMERON FALLS
AGUASABON
THUNDER BAY
MOOSONEE
LOWER MATTAGAMI RIVER PLANTS
OTTER RAPIDS
ABITIBI CANYON
UPPER MATTAGAMI RIVER PLANTS
TIMMINS
Mississagi River
SUDBURY
Lake Nipissing
WANAPITEI PLANTS
SOUTH RIVER PLANTS
BRUCE NUCLEAR DEVELOPMENT
MUKOKA RIVER PLANTS
MADAWASKA PLANTS
ARNPRIOR
BARRIE
CORNWALL
TRENT RIVER PLANTS
PICKERING
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WINDSOR
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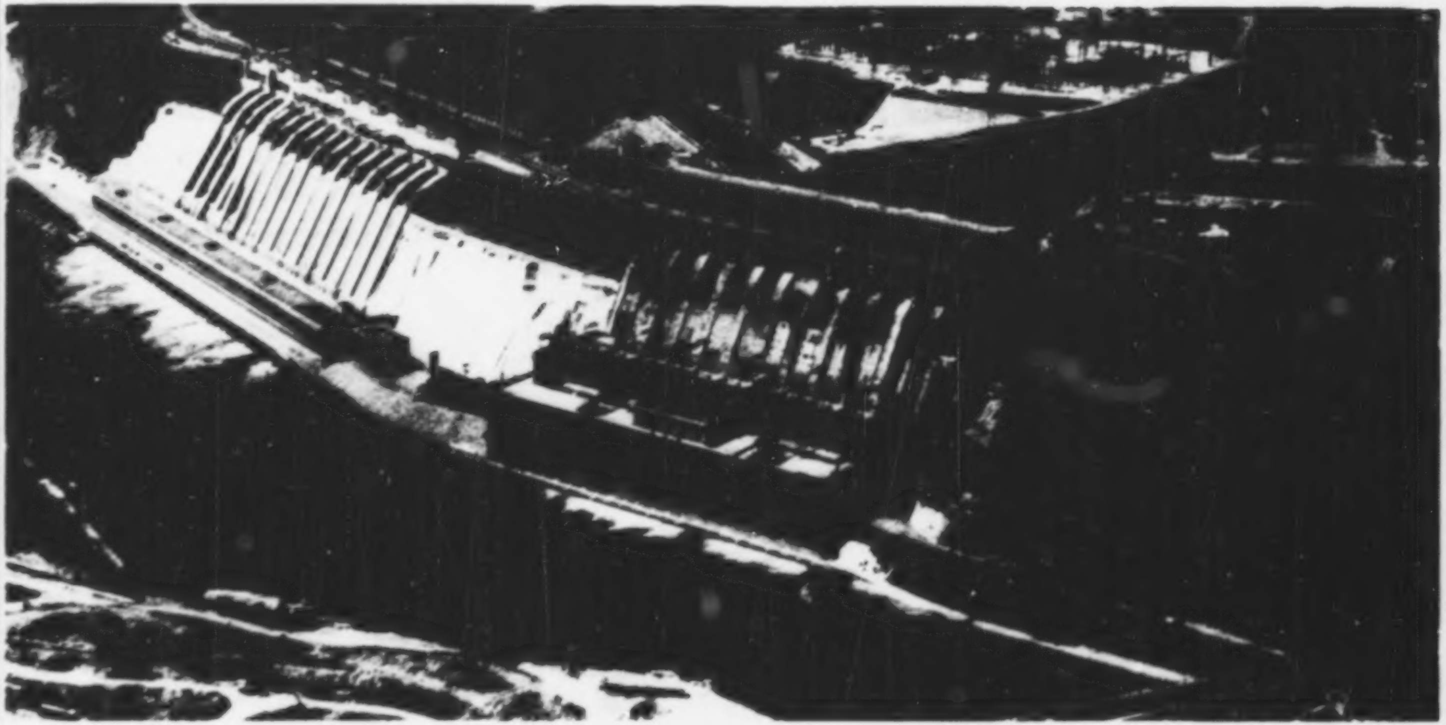
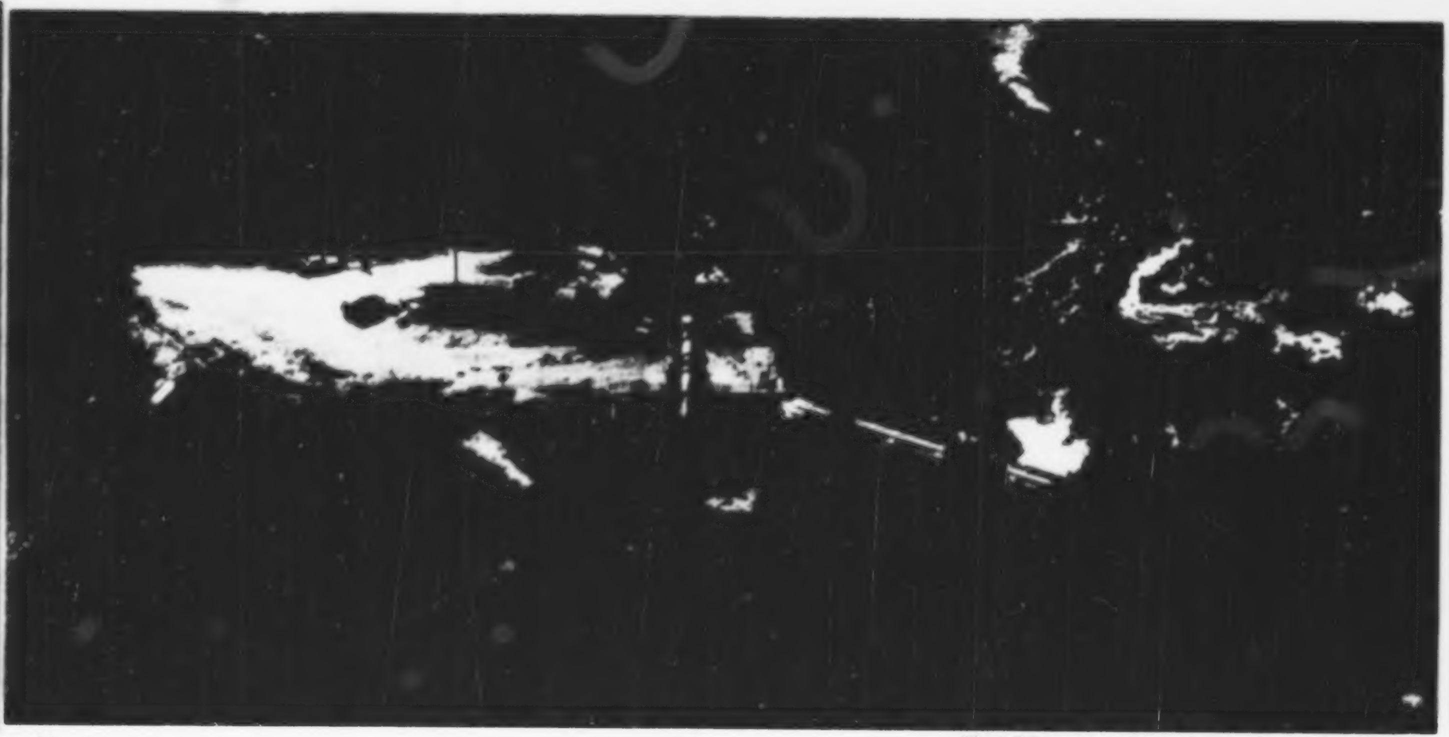
NANTICOK

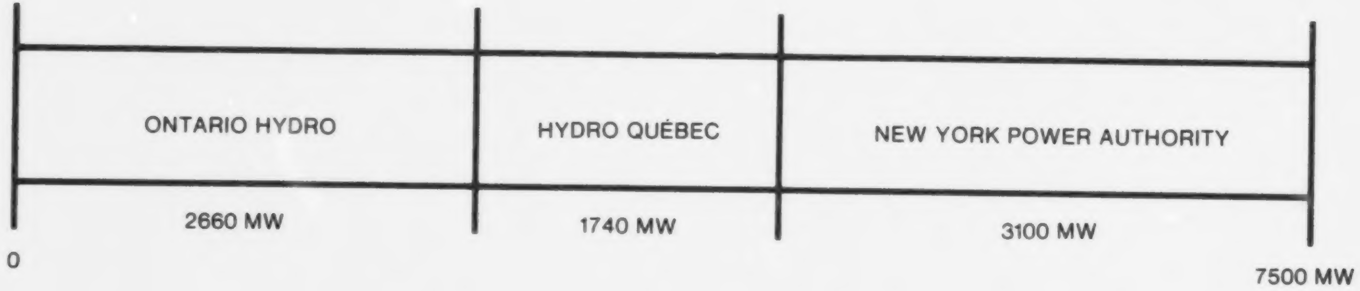


Sir Adam Beck Generating Stations 1 & 2—from U.S. shore.

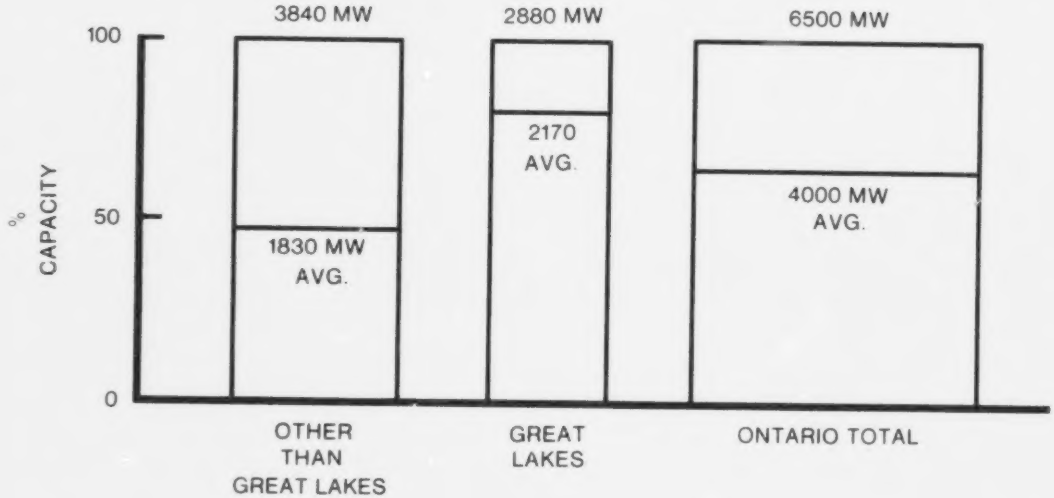


Wasdell Falls G S.—July 22, 1981 with Mini Hydel in place.

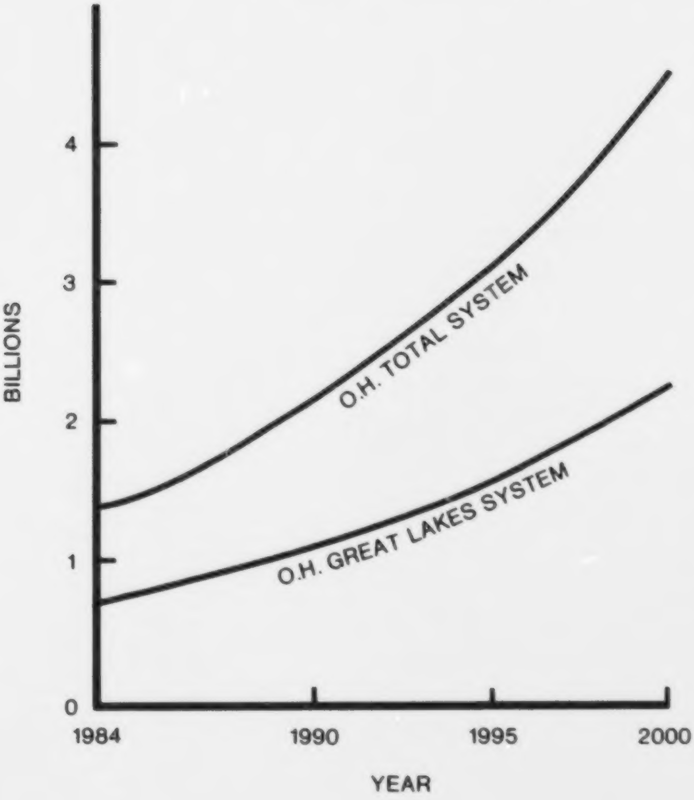
# GREAT LAKES HYDROELECTRIC CAPACITY



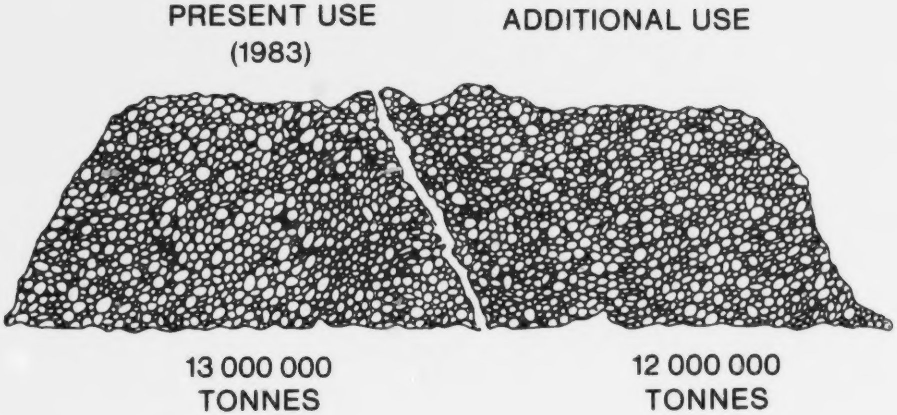
# ONTARIO HYDRO
# HYDRAULIC CAPACITY VS ENERGY



# ANNUAL REPLACEMENT COST OF HYDRAULIC RESOURCES

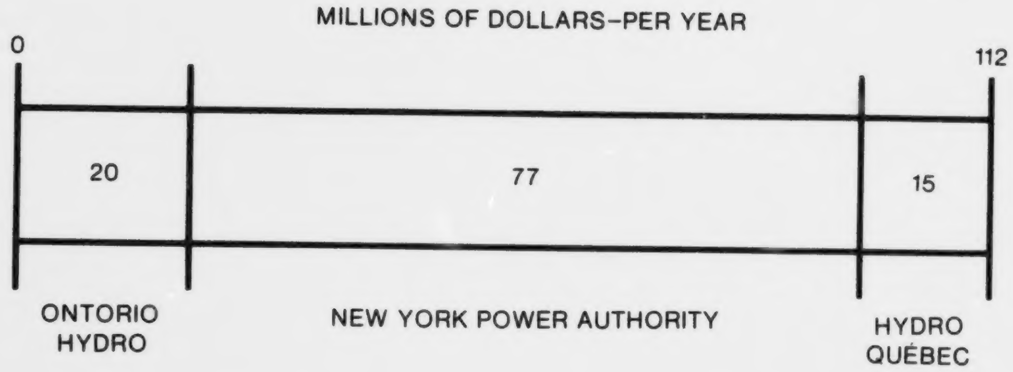


# ANNUAL COAL CONSUMPTION



EFFECT OF LOSS OF HYDRAULIC RESOURCES

# FLOW REDUCTION LOSSES
## 10,000 Cfs



## Rear Admiral Robert W. Timbrell

*Royal Canadian Navy (retired)*
*President, Dominion Marine Association*

# A Vital Transportation Highway for Commercial Shipping

*Admiral Timbrell joined the Royal Canadian Navy in 1937, serving five years with the Royal Navy in the Atlantic, Caribbean, Mediterranean and Norwegian Seas. During World War II, he took part in the Dunkirk evacuation and later served on various destroyers, including North Atlantic convoy duty. His last seagoing command was a Canadian aircraft carrier.*

*Since 1973, he has been President of the Dominion Marine Association, a group embracing 19 Canadian shipping companies interested in fostering world operation of ships under the Canadian flag.*

I am delighted to have this opportunity of talking to you about the Great Lakes-St. Lawrence shipping industry and its current challenges and concerns.

You are all in a general way familiar with the Great Lakes-St. Lawrence Waterway, but perhaps it would do no harm to describe briefly the salient features as they affect my industry.

Stretching across 32 degrees of longitude, the system is the world's largest and one of the most important waterways. It is navigable from the Atlantic to the head of Lake Superior—2,400 miles—equal to the distance between Halifax, Nova Scotia and Plymouth, England. In the process of navigating the system, ships are lifted some 600 feet (or 184 metres) above sea level through three sets of canals and locks. The first is the International St. Lawrence Seaway from Montreal to Lake Ontario, the second is the Welland Canal, an all-Canadian system that accounts for a lift of 376 feet (or 99 metres) by-passing Niagara Falls,and the third is the St. Mary's Canal at Sault Ste. Marie, Ontario, which is U.S. owned.

To place this sytem in its proper perspective, may I be permitted to remind you that the Panama Canal lifts ships approximately 50 feet in their transfer from one ocean to the other, and the Suez Canal is a sea level waterway with no locks. The Suez and Panama Canals are acknowledged as vital to the requirements of international trade. But our St. Lawrence-Great Lakes System, an engineering marvel that permits the lifting of large ships 600 feet to the level of Lake Superior, is seldom acknowledged in the same vein.

It may also interest you to know that the area between Windsor and Detroit is today the busiest waterway in the world. More tonnage passes this point on a given day than anywhere else in the world. Yesterday, the busiest point would have been the Strait of Malacca near Singapore: today it is here in North America.

The navigation system as we know it today was not completed until the present century, but its potential was foreseen more than two centuries ago.

The first vessel on the Upper Lakes, and the first of any size on any of the lakes, was LaSalle's famous "Griffon". She foundered and was lost returning from her first voyage in 1679 and her loss was prophetic. Sailing ships numbering into the hundreds were lost before modern charts, navigation and weather forecasting removed the major hazards from lake travel.

By the 18th century, a large shipping industry was established on the lakes. There were more than 2,000 ships of sail registered on the Upper Lakes alone. These fleets served the fur trade and the advancing frontier of pioneer settlements, carrying all manner of freight, from horses to hatchets, household and trade goods, passengers and armies. Grain moved west in those days while downbound cargoes were furs.

Today, the Great Lakes Basin-St. Lawrence Waterway serves approximately 61 million people, spanning the border, and this inland waterway transport system is being continually developed, maintained and paid for by Canada and the United States. These two countries share in the costs for the navigational aids, dredging, ice breaking services, search and rescue, etc., a unique feature not to be found in any other transport mode within Canada or the United States.

Without any doubt, water transport is the most energy-efficient mode in the movement of bulk cargoes. Research has revealed that the tonne-kilometres of cargoes that can be carried by various transportation modes per litre of fuel oil are:

| | |
|---|---|
| **by ship** | **–213** |
| **by pipeline** | **–106** |
| **by rail** | **– 89** |
| **by truck** | **– 25** |
| **by air** | **– 3** |

In an average year, cargoes totalling over 270 million tonnes are moved within the Great Lakes by the marine mode. By far the greater proportion of these cargoes are carried in Canadian or U.S. Flag Ships. However, there is a third player in this scenario, and here we see ships from 20 other countries which collectively move approximately 20 million tonnes in and out of the system.

For comparison, the total cargoes carried by Canada's railway is approximately 210 million tonnes per average year.

My association was established in 1903 by a group of shipowners whose common interest was to promote safe water transportation to the benefit of Canada. Today, we have 140 Canadian Flag Ships comprised of tankers, dry bulk carriers and self-unloaders operated by 17 member companies.

The size of our ships using the Seaway and/or Welland Canal is limited by the dimensions of the lock to 730 feet in length, 76 feet in breadth and 26 feet in draught.

Nonetheless, our ships are large and very efficient, for example the 730-foot laker carries 26,000 tonnes of grain, over one million bushels. This amount would require a train five miles in length and that is for only one ship load.

In 1983, we loaded 16.6 million tonnes of grain (or 610) million bushels) out of Thunder Bay alone, apart from the enormous fuel saving a ship offers vis-a-vis rail, the price was right, we charge $13 per tonne from Thunder Bay to Quebec City whereas the rail costs are $26 per tonne.

The four principal commodities that are moved by water transport within the Great Lakes are grain, coal, iron ore and petroleum products.

In keeping with the agreed Canadian/U.S. intention to restore the quality of the water within the Great Lakes, every ship that operates within this area must, as of February 1983, be fitted with an authorized sewage treatment plant or holding tanks.

The Seaway System operates 24 hours a day, 7 days a week for approximately 8 and one-half months of the year. The average season commences around April 1 as ice disappears from the various lakes, and operations cease around December 15.

Approximately 5 years ago, it was projected that, with the growth of traffic at that time on the Great Lakes-St. Lawrence System, the Welland Canal would reach capacity by the mid 1980s. When this point in time arrived, it would then be necessary to take one of the following three steps:

1) Cease any further growth in the system which would not be in tune with the future development of Canada nor the United States.
2) Build a new Welland and Montreal-Lake Ontario Canal that would accommodate larger ships. Not only is this action expensive but it is also time-consuming; nevertheless, this will happen at some point in the future. (Remember now, the costs will be shared between Canada and the United States).
3) The third alternative is to extend the present operating season beyond December 15. It is most important that any season extension is tied to the need for the movement of a greater volume of cargoes rather than spread the present cargo volume over a longer time frame.

To prepare for season extension, a number of steps have already been taken, namely:

a) The Canal Authorities have installed heaters on all gates in order that ice accumulation on these vital points can be prevented.
b) To disperse the broken ice that in its seaward passage which would otherwise flow into an open lock thereby barring a ship to enter the lock, a simple but effective diversionary method has been developed to keep this broken ice out of the open locks.
c) To ensure safe navigation of the tight passageways throughout the Canal system and the rivers, a navigation system is being designed permitting the ships to move safely in the narrow channels when the buoys and other navigational aids have been removed due to winter conditions.

An interesting feature that is being developed is for a more economical method of breaking ice that would otherwise prevent the ship from negotiating the canals or entering the harbours. This system is developed from an air cushion vehicle, which, when operating on the bow of a ship, forces air through the ice downwards, thereby depressing the supporting surface of the water, permitting an easier breakage of the ice. With the use of an air cushion vehicle, the improvement to the average icebreaker is in the order of 800 per cent when breaking ice up to one metre in thickness.

Another step to the extension of the current season within the great Lakes has been in the design of the Canadian ship the "M.V. Arctic". The ship is of seaway dimensions but is built as an ice-breaking bulk cargo carrier. The M.V. Arctic is capable of transiting one metre of ice at a constant speed or a greater thickness of ice by use of its icebreaking qualities. Throughout the summer months, this ship operates in the Canadian Arctic and, because of her ocean-going qualities, she is a very versatile ship. The results of on-going experiments being carried out on this ship will be very valuable for future ship designs operating not only during the winter within the Great Lakes, but in the Canadian Arctic.

One factor which has emerged from the current recession that both our nations are experiencing is a delay in the Welland Canal reaching capacity by the projected mid 1980s. The projected capacity date now, assuming recovery within the next three years, is the mid 1990s.

Nevertheless, the appropriate authorities within both nations are satisfied that there will be continual growth within the Great Lakes/St. Lawrence Transportation System, at a minimum, in the order of two percent per year.

With these thoughts as a background, may I now address the Conference topic as seen by shipowners.

Due to the depth of water available within the rivers, connecting channels and harbours, the maximum operating draught for all ships above Montreal is 26 feet. With this limitation, every technological advantage is encouraged to permit the carriage of the largest possible cargoes, still recognizing that the Canal systems in themselves impose very strict length and width constraints to the size of our ships.

In a normal year, there are approximately 9,000 transits within the Great Lakes/St. Lawrence system above the port of Montreal.

With the physical limitations imposed in the construction of the ships, any loss in the current draught of 26 feet will have a major negative impact on both nations. For example, a decrease of one inch will result in the loss of over a million tonnes of cargo capacity per season. Any attempt to offset this loss by increasing the number of ship transits within the current shipping season would only advance the capacity date of the Welland Canal closer to today. To transfer these cargoes to the rail mode would see, at a minimum, a doubling of the shipping charges even if the rail could accept—for Canadian Railways this is very doubtful.

To dredge to a greater depth would require this activity in every harbour, channel, river and canal, an expense which I doubt would or could be met by both countries.

So what do we see ahead?

As all of us know, the last three years have not been banner ones in economic terms. In this industry, we have seen 20 per cent of our lakers laid up last year, and this is being repeated in the 1984 navigation season.

We in the shipping industry are not as sanguine about near future prospects as we were a year ago, but neither are we excessively gloomy. Clearly, there are major structural changes taking place in certain industries, notably steel, that will affect quantity and direction of cargo movements.

At the same time, some other industries we serve are recovering and some, we hope, show real growth potential. I like to think that grain, particularly Ontario grain, falls into this category.

Even during the difficult times, shipowners have not stood still. We are in a period of significant innovation directed especially toward fuel-saving plant and cargo systems.

An example of the latter is the self-unloading ship, which saves considerable time and labour in discharging bulk cargoes; for example, 26,000 tonnes of iron ore or coal can be unloaded in eight hours as opposed to 36 hours when required to use dockside facilities.

Further, self-unloaders have been used to "top-off" large ocean-going ships in mid-river operations in the St. Lawrence with coal exported from the United States destined for Europe and Japan. We are also investigating the application of the self-unloader in the transportation of grain and by conducting experiments in direct ship to ship transfer of grain and with the installation of receiving facilities at Quebec elevators. It is hoped that these experiments will prove successful and lead to lower handling costs, thereby a gain to the farmer.

Our companies are taking possession of the first of several of a new breed of ships, the combination ocean-going laker which will be able to haul grain directly from the lakes to European ports.

There are a number of European ports that, due to navigational restrictions, are unable to accept the very large bulk carriers, and yet these same ports are fully equipped with grain receiving and distribution systems. It is to these ports that our new ocean going laker, with a cargo approximaely 38,000 tonnes, is very much welcome.

In summary, for the future of the St. Lawrence/Great Lakes, I see:

1. A system which has not yet reached its full potential.
2. A system which can be expanded at minimum costs and disruption.
3. Greater recognition by the Canadian and U.S. authorities of its uniqueness by virtue of the international aspect, e.g., Canada/U.S. cost-sharing not found in any other mode.
4. Greater usage as our respective countries develop, and
5. A public demand for more expedient action to clean up and maintain a high standard of water quality.

**W. A. Andrews**
*President, Conservation Council of Ontario*

# Some Possible Environmental Effects of Large-Scale Water Transfer Schemes

*Mr. Andrews received his B.Sc. and M.Sc. in Chemistry at the University of Western Ontario, followed by a B.Ed. from the University of Toronto in 1962. After 9 years teaching in Secondary Schools, he returned to the University of Toronto where he is Professor of Environmental Science and Chairman of Science Education. Author of 18 textbooks, including works on Freshwater Ecology and Environmental Pollution, Mr. Andrews is now President of the Conservation Council of Ontario. The Council embraces 30 organizations concerned with encouraging a very broad, balanced environmental perspective.*

## Abstract

Further large-scale diversions of water into or out of the Great Lakes Basin could markedly disrupt ecological balance in the Great Lakes Basin ecosystem. Scientific studies are urgently needed to ascertain the environmental impact of proposed diversions. These studies must be completed before engineering and political interests have invested significant capital in diversion plans, and they must be based on an ecosystem approach to management. This approach focuses primarily on ecological phenomena rather than on the traditional political economic, engineering, and jurisdictional perspectives. While the studies are being conducted, every effort must be made to implement conservation measures which will lessen the demand for Great Lakes water. Such measures must give prime attention to the irrigation of agricultural lands, and should involve the evaluation of current land uses in agricultural regions of arid and semi-arid regions of North America.

## Introduction

Canada appears to have vast water reserves, whether they be judged on the basis of per capita availability of water or on the basis of the magnitude of lake and subterranean storage areas and total discharge from rivers. Central to these reserves are, of course, the Great Lakes which we share with United States. Vast though these lakes may be, they have shown for decades the symptoms of misuse and mismanagement that have arisen largely because utilization has been based on the assumption that their vastness permits almost limitless exploitation. Several events, however, are gradually bringing this important resource into its proper perspective. Among these events are the deterioration of the Great Lakes fisheries, contaminated swimming beaches, identification of hazardous wastes in municipal drinking water, abnormal water levels on the lakes, and indications that impending water shortages in parts of the United States may increase the demand for water from the Great Lakes.

These events are forcing us to acknowledge that water is our most valuable resource and that supplies are not endless. Further, many of us now concede that the Great Lakes Basin, like any ecosystem, has a finite carrying capacity which, in spite of the huge volume of water in the basin, can be dramatically and dangerously altered by the imposition of undue environmental stresses. Large-scale diversions of water, into or out of the basin, constitute one such environmental stress. The major environmental consequences of such water transfers are the subject of this paper.

## An Ecosystem Approach to Management

Subsequent to the 1972 Great Lakes Water Quality Agreement, the governments of Canada and the United States have implemented programs to mitigate environmental damage in the Great Lakes and enhance water quality. The progress of these programs has been monitored by an extensive surveillance program which stresses predominately geophysical and chemical water quality parameters. Such studies have added immeasurably to our understanding of the Great Lakes. They are, however, only a small part of the understanding that is needed for effective management and restoration of the lakes. The International Joint Commission recognized this fact when it asked the Great Lakes Research Advisory Board in 1977 to prepare a statement on the scope and implications of an ecosystem approach to transboundary problems in the Great Lakes Basin. This report, titled "The Ecosystem Approach" was released in 1978.[1] It defines the Great Lakes Basin Ecosystem as follows:

> *. . . the Great Lakes Basin is an Ecosystem composed of interacting elements of the hydrosphere (natural waters), atmosphere, lithosphere (soils, rocks, sediments) and biota (encompassing man) in the drainage basin of the St. Lawrence River at or upstream from the point at which this river becomes the international boundary between Canada and the United States."*

The ecosystem approach recommended in this document involves the examination of the Basin as an Ecosystem, simultaneously relating events within the Ecosystem to those in surrounding areas in biospheric perspective. In the view of the Conservation Council of Ontario, this ecosystem approach must be the basis for the evaluation of all proposals for large-scale diversions of water into or out of the Great Lakes Basin. Simply stated, this approach has "a focus primarily on ecological phenomena, rather than on the conventional and historically dominant political, engineering, economic, or accounting perspectives,"[2] and it has a biospheric perspective which takes account of transport in and out of the ecosystem.

## Some Possible Environmental Effects of Out-of-Basin Water Transfers

The main large-scale uses of water in the Great Lakes Basin are clearly identifiable:

- Urban and rural domestic use
- Industrial uses (including mining and manufacturing)
- Agricultural uses (livestock and irrigation)
- Power generation
- Fish and wildlife production
- Recreation (including tourism)
- Navigation

Though diversions out of the Great Lakes Basin may have positive values for some subsets of these seven major uses, overall both the environmental and economic effects will be negative within the Basin for all seven uses. Much attention has been given recently to quantifying the effects of lower lake levels on power production and navigation, but a serious deficiency exists in Canadian knowledge about the effects of lower lake levels on environmental factors such as fish and wildlife habitat, human utilization of the shoreline for recreation, and water quality. Large projects such as trans-basin water transfer systems are, by their very nature, irreversible. Once they are operational, it becomes impossible to mitigate unforeseen environmental impacts. It is imperative, therefore, that scientific studies be conducted to ascertain the full environmental impact of proposed diversions well before significant capital has been invested in the projects. The following are some thoughts on two major areas which require detailed study:

1. *Effects of Lower Water Levels on Fish and Wildlife*
   The shallow areas of the Great Lakes, the ones that will be most affected by lower water levels, are by far the most productive areas for fish. These shallows are generally associated with marshes, and are the vital spawning and rearing habitat for small mouth bass, large mouth bass, northern pike, and muskellunge. They are also the natural habitat of many other species of fish. Desirable and badly needed fish habitat could be destroyed by a small decrease in water level.

   A drop in water level of just a few centimetres will eliminate vast areas of the type of marsh which constitutes our most productive wildlife habitat. For example, calculations have shown that a 15 cm drop in Lake Huron would expose a strip of marsh over 300 m wide and 6.5 km long in Saginaw Bay.[3] Narrow though such strips of marsh may be, they support a great abundance of wildlife, both aquatic and semi-aquatic. Many species of birds and mammals are absolutely dependent upon marshes for their existence. The young require these wetlands for feeding, and for protection from enemies and the elements. Adult waterfowl use them for feeding, nesting, and resting. Many important game species and furbearers are among these marsh-dependent animals. Mink, muskrat, ducks, geese, shorebirds, and coots are examples.

   It has long been known that lower water levels are associated with reduced productivity in the littoral zone of lakes. Low levels result in decreased water volume and surface area. The shoreline moves out, exposing less fertile soils which will be devoid of vegetation and slow to develop any cover. Wave action will stir up the finely-divided substrate in this area, resulting in an increased turbidity which will lower the productivity of the area still further. Dropping water levels will also lower the thermocline, thereby reducing somewhat the availability of habitat to commercial fish species such as the chubs.

### 2. *Human Utilization of the Shoreline for Recreation*

About 35,000 members of the Federation of Ontario Cottagers' Associations, Inc. reside on or near the Great Lakes, and they represent just a small portion of the total number that use the shores for recreational activities. Though lower water levels may enhance swimming beaches and lessen the erosion of shoreline properties, cottagers are concerned about possible negative impacts on boating and fishing opportunities. A small decrease in water level will greatly affect the traditionally shallow areas such as connecting channels, harbours, and bays. Although dredging may be used in deeper waters where commercial navigation is affected, this is not a feasible solution in the countless bays and inlets where sailing, canoeing, and water skiing are enjoyed. Further, existing docks may be rendered useless by lower water levels.

In addition to its negative effect on recreational boating, a decrease in water level will also affect those who enjoy the viewing of waterfowl and shorebirds, sports hunting, and sports fishing.

### Summative Comment

Definite cost figures cannot be attached to the potential damage to docks, the loss of boating opportunities, the decrease in the enjoyment of fish and wildlife, or the destruction of marsh habitat. Conservation is a state of mind, an intangible benefit. And who can give the real dollar value of a relaxing weekend at a cottage? Fortunately, an ecosystem approach to management is not based on such narrow considerations.

## Replenish The Water by Diversions into The Basin?

Many will argue, of course, that water levels in the Great Lakes Basin need not drop. Water diverted out of the Basin can be replaced by water diverted into the Basin from the Hudson Bay drainage system. Two such diversions already exist, at Long Lac and Ogoki. The Conservation Council of Ontario asks if the true environmental impact of those diversions has been adequately assessed and questions whether the north can sustain further projects of this type. The development of any scheme of dams, reservoirs, and channels implies that alternative uses of the resource have been forgone. The attendant water impoundments in storage and transfer systems may inundate valuable mineral reserves, destroy the spawning grounds for anadromous fish, eliminate vast tracts of boreal forest, dissect agricultural land, disrupt the habitat and migration routes of mammals, decrease recreational opportunities such as wild river canoeing and fishing, and displace native people from their lands. Further, have the long-term ecological consequences of the integration of the biota from the Hudson Bay drainage area and the Great Lakes Basin been thoroughly assessed?

Have the possible consequences of extensive diversions on the microclimate and, indeed, on the mesoclimate in the region of export been assessed? And, has the potential impact on the ecology of James Bay been documented and evaluated?

Integration of water systems is not inherently good, and investigations and evaluation of the consequences of such action should be initiated on the basis of that fact. Though the north consistutes over 70% of the area of Ontario and holds about 10% of its population, we know little about it. After close to seven years of work and expenditures of nine million dollars, the Royal Commission on the Northern Environment has yet to release a final report. Until we know more about the north than we do now, diversion projects that tamper with its waterways should not even be considered.

## Irrigation: Is It Worth The Price?

Irrigation is the most demanding water use and, possibly, the most controversial. Half the water used in the United States each year goes for irrigation, and this water is lost to other users because of evapotranspiration. Taking this into account, about 85% of all the water used in the United States (rather than just "borrowed") goes for irrigation. Irrigation is used in arid and semi-arid areas to produce commercial crops of high monetary value. It is also used in non-arid regions to increase crop yields and to get better quality produce. About half the water directed into agricultural uses is wasted, says the United States General Accounting Office. Why is this so?

The price paid for irrigation water is normally far below its real cost or worth. The production of crops in arid regions is, strictly speaking, unprofitable. It is only possible because of direct or indirect subsidies. Water has traditionally been treated differently from other marketable commodities that are "directed to their highest and best uses by the price system. Historically, water's seeming abundance contributed to its allocation at prices reflecting the costs of capture and distribution, not its economic value. Because of the 'water-is-different' syndrome, the solution to water shortages through time as need grows has been to develop new water supplies rather than to raise prices to increase the supply to meet the fixed demand."[4] And herein lies the reason for the lack of attention to water conservation and the current interest in the use of Great Lakes water to irrigate the American Midwest and Southwest.

This paper discussed earlier some possible environmental effects of trans-basin diversions on the Great Lakes Basin Ecosystem. Because we promote an ecosystem approach to management with a biospheric perspective, the Council is also concerned about possible environmental effects on the receiving ecosystem, the American Midwest and Southwest. What could happen if massive quantities of Great Lakes water are transferred to these areas of the United States? When this relatively cool water moves to southern latitudes, heat will be absorbed from the environment to warm this water to the ambient temperature.

This absorption of heat and the resultant evapo transpiration could significantly affect microclimates and even mesoclimates in the area. In addition ecological problems could arise from any mixing of the biota of the exporting and importing regions.

## Recommendations

The Conservation Council of Ontario offers the following recommendations for consideration before any large-scale trans-basin transfers of water are contemplated, in the belief that a continent-wide water conservation program could forestall and even make unnecessary such diversions.

- Reduce markedly the quantity of water used for agricultural irrigation, not just in the American Midwest and Southwest, but across the continent as a whole. The following are some possible ways to do this:
  a) Use less water on a given crop, with the understanding that yields may be lower and quality poorer.
  b) Update irrigation technology to minimize runoff and its attendant problems of soil erosion and water pollution.
  c) Irrigate mainly water-efficient crops.
  d) Use soil management techniques which increase the water-holding capacity of the soil.
  e) Reallocate land uses in order that water-demanding crops are not grown in areas with mounting water deficits.
- Reduce non-agricultural irrigation such as the irrigation of golf courses and lawn watering. Why, for example, are lawns in Toronto commonly planted with water-demanding Kentucky and Merian blue grass, when native grasses would survive without irrigation?
- Encourage water conservation across the continent by realistic pricing that assesses the true cost of the water back to the user.
- Develop better methods for the impoundment of flood waters in order that they can be used subsequently for irrigation.
- Avoid water pollution which, in many instances, has rendered local waters unfit for irrigation.

## Conclusion

The Conservation Council of Ontario recognizes the need for long term planning for future water requirements and conservation in the continent as a whole, without regard to provincial, state, or international boundaries. This planning must revolve around an ecosystem approach with a biospheric perspective, and the conclusions of scientists must not be overriden by the demands of politicians who may be sensitive to the pressures of local, short-term interests. Short-term benefits (or seeming benefits) for a local region cannot be allowed to endanger the ecology of other regions of the continent. "Water is not only a resource commodity but also a key element of the environment needed to support wildlife habitats and traditional ways of life."[5]

After a few thousand studies of acid deposition, we are still commissioning further studies, conducting "band-aid" treatments such as the liming of lakes, and accusing Americans of polluting our lakes, while our coal-burning power plants and smelters continue to pollute the earth's atmosphere, and our automobiles emit over three times the nitrogen oxides concentration of comparable American models. Had acid deposition been approached three decades ago using an ecosystem approach with a biospheric perspective, the problem probably would not exist today. We should keep this thought in mind when we are confronted with proposals for trans-basin water transfer schemes.

## Notes

[1] Great Lakes Research Advisory Board, *The Ecosystem Approach*, special report to the International Joint Commission, Windsor, Ontario, 1978.

[2] Brenda J. Lee, Henry A. Regier and David J. Rapport, "Ten Ecosystem Approaches to the Planning and Management of the Great Lakes," *Journal of Great Lakes Research*, Vol. 8, No. 3, (1982), pp. 505-519.

[3] *Adverse Effects of Low Water Levels on Conservation Interests*, Proc. of the Great Lakes Levels Conference, 28 July 1964, p.95.

[4] Terry L. Anderson, *Water Rights* (Cambridge, Mass.: Ballinger Publishing Co., 1983), p. 85.

[5] Harold D. Foster and W.R. Derrick, Sewell, *Water: The Emerging Crisis in Canada* (Toronto: James Lorimer & Co., 1981), p. 34.

# Session 3, Questions and Answers

*Question:*
William Griffin, Michigan. I was struck by the characterization this morning of Lake Michigan as the "wild card". I have a thought that Lake Michigan is not as wild a wild card as it might appear to be at first glance. Lake Michigan, hydrologically, is no different than a river flowing into a boundary water. Lake Michigan is not, by definition, a boundary water as defined in the 1909 Boundary Waters Treaty for only one reason, and that was because the parties of the 1909 didn't want to give the Joint Commission jurisdiction over it. That's probably not the way to go now, but my main thought is that the Boundary Waters Treaty does not replace or displace customary international law. It only supplements customary international law. The fact that Lake Michigan is not under the jurisdiction of the I.J.C. simply means that any diversions from Lake Michigan become an immediate subject of intergovernmental federal foreign external affairs negotiations. In terms of the U.S. Constitutional law, anything that the federal government does under its external relations formulations power overrides any regulations of interstate commerce by the Congress. So if the Congress under its interstate commerce authority were to authorize, give permission that is, to any state to export water from Lake Michigan, any acts to carry that out would become immediately the subject of international negotiations between the two federal governments, where the principle of equitable utilization would apply, which is a firmly established principle of customary international law around the world. This doctrine of equitable utilization has been applied hundreds of times in river basins and drainage basins all over the world by international arbitrators and courts, and therefore these principles have been used by intergovernmental negotiators for settlements to avoid going to international litigation. So I just don't see that there is any real problem in relation to Lake Michigan. I think what we need today is an umbrella organization of the Province and Great Lakes states because each province or state now has its own state or provincial council of the environment or of this or that. Everybody is studying it on his own. What we need is an umbrella organization which is a legally recognized entity, whose actions can be under the foreign relations powers, the external relations powers of the federal government and give to the entity authority to make decisions for planning and use of the water of the basin. Once we get a plan, the important thing now is to get such an umbrella organization under way and then for such an umbrella organization to get on paper documentation of 100 per cent utilization of the waters of the basin within the basin and that will be the best defence to any efforts to transport water from Lake Michigan of Lake Superior to the western/ southwestern United States and, if that should ever come about, you

will find that the people of Minnesota, Wisconsin, Michigan, Indiana, Ohio, Illinois regard the western and southwestern United States in relation to export of Great Lakes water, they are the adversary, not Ontario. When we say it's our water, we mean by the word 'our' that it includes Ontario and Quebec.

*Moderator:*
Thanks for those comments. Would any panelist care to respond to that? I'd only say that I know that when the original Great Lakes Commission was established, there was some thought and possibly even some formal proposal given to including the provinces which presented some problems at the time with the Congressional consent to that compact as I understand it. But the notion that you put forth is certainly an interesting one and one that ought to be given further consideration.

*Question:*
I'm one of the principals of Walter Brown Associates, Environmental Consultants. I'm also interested in the Green Revolution. I was interested in Professor Andrews' talk on ecosystem and ecology; however, my question, I hope, would be directed to Senator Durenberger, but unfortunately he had to go back. It concerns the Garrison Creek Diversion which may, at first sight, have nothing to do with the Great Lakes system, but it is a diversion and one of the problems is adding to the salt content of the Souris River, not to mention other minerals which might be objectionable in other animals and fish species because, when you irrigate, you increase the salt content to a point where, in arid regions, you can no longer farm because it kills the crops. The farmers in the Sacramento Valley discovered this the hard way. By adding extra salt, it's hardly fair to the farmers of Manitoba who want to irrigate their farms, to add an increased salt content, therefore I submit that to discharge this into the Souris River would be unacceptable. Now, when Senator Durenberger mentioned $5,000 an acre for irrigation, it seems an astronomical amount. Would this include treatment of the water which would include precipitation of sediments and possibly the use of membrane filters to take out the salt content, which is chlorides and sulfates and various other soluble materials? The suggestion came to me that possibly this water from the Missouri River could be used for irrigation possibly a little further south so that the water could be diverted into the Mississippi River and then this could be used to supplement the aquifer in Arizona. As an alternative to diverting water from the Great Lakes, which of course is untenable, it's clear that it's unacceptable, I wonder, Professor Andrews, if you would comment on this.

*Professor Andrews*
I'm not sure what I'm commenting on—you've pretty well tied it up nicely. It is true that irrigation water, I don't care where it is, if you put it on arid land, it's going to increase the salt content. When that water lands, unless you really, really soak it and wash it right down to the water table, when the water evaporates, it moves back up to the top, taking minerals with it, and I've seen all kinds of irrigated land in western Canada that looks like it's covered with snow, it's absolutely white. They're scrambling now to develop varieties of wheat that will grow in that salty soil, and they actually have succeeded in doing so. But you can only keep doing that, I suspect, for so long, until eventually you'll run into the point where you can't grow anything at all. So, as long as you irrigate on arid land, you're likely going to gradually make the soil more and more salty.

*Moderator*
Are there any other comments or questions?

*Question*
I have a question, Tovell, Toronto. It's probably addressed to you because I'm not sure who else can answer it. What diversion studies are being made at this moment in the back rooms, that Mr. Andrews referred to, and also, have not been referred to in any way in any of the papers other than obliquely?

*Moderator*
I have no idea.

*Professor Andrews*
I made that up, too. I just have a suspicion, that's all.

*Moderator*
I think his point is an interesting one. One of the things that has concerned the Governors' Task Force on Water Diversions somewhat, as we look at some of the possible institutional solutions, is that we don't know what kind of research is out there, not only whether or not people are looking at if there are proposals being developed by the Corps of Engineers or by private companies or whatever, but also that we really don't have a good handle or there hasn't been an attempt made to pull together the existing studies and research and analysis on water diversions and the economic feasibility studies and so forth. This conference has obviously done a lot to do so, and the Proceedings will be an excellent starting point for that gathering of information, as we obviously have some of the best expertise available with us the last couple of days. I also know that there is some work going on at the University of Michigan that will pull together an annotated bibliography of some of the ongoing research about this, so we're getting there. As someone said, it's a long process and that's certainly an important part of it.

*Question:*
I'd like to direct a question to Rear Admiral Timbrell concerning your paper, sir. We've heard from Mr. Andrews the importance of looking at things in terms of an ecosystem; economists do the same sort of thing, it's often said that something is too costly or that it has a great benefit without looking at all of the variables of cost. It becomes important, I think, to look at all of the costs. For example, when I look at some of your comments, I get nervous. I see things like a proposal to dredge, but, at the same time, saying that you would doubt very much whether the countries would consider that they could meet the cost. Well, there are environmental costs. If we've got ice a metre thick kicking around loose in the lake, what do we know about jams and what they will do to shipping, never mind to other things; what will they do to hydro-electric generating stations? What will those ice jams do if they're combined with other substances from the river beds? Clearly, there are major structural changes taking place in certain industries, notably steel, that will affect quantity and direction of cargo movement. I'd like to get more specifics on that. I'm not familiar with those changes, and I'd like to know more about it. Perhaps you would comment on it.

A system which can be expanded cost and disruption in your summary. I don't know what kind of expansion you have in mind, whether you're talking about 12-month navigation or whether you're talking about dredging to have more draft on the ships or I'd like more there, and a public demand for more expedient action to clean up and maintain a high standard of water quality seems to me to be an incongruous item in the midst of the rest of the papers. So I'm quite confused and quite nervous about the paper. Could you comment further on some of these points, sir?

*Rear Admiral Timbrell:*
I'll take you back to your latter point to my first statement where, as seamen, we've been training from day one to respect the quality because we recognize, in our early days it was drummed into us that if we didn't respect the seas and give consideration to maintaining and hopefully improving the quality, the price would be too great to pay at a later time. We've seen this in the Great Lakes, where we've ignored that basic law and have poured in our chemicals, waste, and yet ships contributed less than half of one per cent of the problem, and this was recorded in both the Congress and the House of Commons, and yet we've taken every step to ensure that that has been rectified. I still believe, and we see it around, that there are a number of cities and towns that could speed up installing treatment plants, we see it around the City of Ottawa where I work, the Ottawa River receives an unnecessarily large amount of garbage and it's quite a headline to see that the three swimming areas of the National Capital of Canada have been closed to swimmers because the water is polluted or the Port of Montreal, which spills all of its residue into the

St. Lawrence River, is still waiting for its major treatment plant. With respect to the fact that the system could be expanded, like most transportation systems we have our highs and lows. We are very busy at the opening of the season, April through to about May, and towards the close, from September through to December. But in the period May to September, our cargos are low because they have moved all the grain—the bins are empty and we have pretty well restocked the stock piles of the steel plants and hydro plants. But there is a period there in mid-summer where we could make good use, without making one change in the system, other than the utilization by ships. Further, the system itself can be increased in usage because, even today, although we have less ships in the fleets that I represent, we have a higher tonnage, we're taking the smaller ships out and replacing them with maximum-sized ships. It's a feature of the size of economics. One ship can carry 26,000 tons as opposed to 6,000 tons of 50 years ago. To build a new highway or railway in Canada, you know the agony we would go through for the expropriation of our land. You know what you and I would feel if they took over our green or brown lawn just to put a highway through. And yet we have a system that's under-utilized. I cannot help forget, too, that the system is sustained by two countries, as opposed to any other system in Canada. When I talked about the iron ore as a decline and change in pattern, if you look around United States steel plants around the Great Lakes, they are reduced in numbers every year. Ever since the recession, many of the old plants have been closed, some permanently. They were out of date, were expensive to operate, or were not productive. A number of the steel plants have moved south to the southern climes, Missouri, Mississippi, where they have access to a much higher grade or ore, resilient ore, at a lower price. Features like that have taken place. Other patterns are changing; I mentioned Ontario grain. Ontario is now becoming a grain exporting area as opposed to an importing one 10 years ago. They are now exporting your corn to Europe. The pattern is changing. Those are some of the highlights.

*Question:*
I have a question to direct to Mr. McIntyre, and I don't want this to sound hostile. It has to do with projections and things like this. I don't want to beat you for some of the faults that should actually be attributed to some of your predecessors, perhaps. My name is Henry Regier, University of Toronto. Back about 12 or 13 years ago, I was a member of the Ontario Advisory Committee on Energy and George Gathercole was also a member of that Committee. At that time, we argued that there should be some efforts made towards conservation. The policy at that time of the leadership of Ontario Hydro was that Ontario Hydro should not embark on a program of advertising conservation. Also, at that time, the autonomous 7 per cent growth rate was still in place—I gather it was called the autonomous 7 per

cent growth rate because it depended on no empirical justification whatever, it was just that you started with 7 per cent because that's how fast you want the economy to grow, and that was full justification for the 7 per cent. This is a bit of ancient history, now. I'm not quite sure that it is ancient, but I'd like to ask the question "How far along is your planning process towards being reasonable?" Thirteen years ago, it was unreasonable to the point of insanity, I think. How far along are you in the direction of becoming reasonable?

*Mr. McIntyre:*
Well, I had this discussion the other day, and I think, you've obviously put a very difficult question to me because you've obviously got a view of your own and you want me to . . . What I would say right now is that we are assuming, I guess I should say hoping, for a fairly high degree of conservation in the long-term in Ontario. One of the reasons I'm saying that is that, living in Ontario, we are building a Darlington nuclear generating station, and there has been a lot of opposition against it, most recently at our head office, where people have been in and been arrested for it. Beyond that, though, in terms of looking at generation, when it takes you 14 years to do something, you do have to look beyond it, we really haven't got very much if you want to call it on the drawing board. We've got a lot of faith, maybe, on that drawing board, we are assuming that, if the load does grow, conservation will be able to, in the '90s, hold it down. We are hoping to get into the small area a lot more. What Ontario Hydro would like to do, as some various American utilities have done, is go into the various factories in the Province, and take a look, it may be cheaper for us to invest some money in that factory and improve the efficiency of the equipment that it has there, in a sense buy some megawatts or kilowatts back from them because it's a lower cost for us and a lower cost for the environment, and use that to dampen the demand. We have no large-scale generation of any kind on the drawing board beyond Darlington. To be honest with you, there are a certain number of people in Ontario Hydro for whom the lack of future capacity on the drawing board is causing a lot of concern. If the economy does turn around and get going, we are forecasting just over a 2 per cent long-term electrical load growth. A lot of people are very concerned that there's just too low a forecast for Ontario. For example EM&R in Ottawa is forecasting a little over 4 1/2 per cent long-term electrical load growth for the Province of Ontario. That's higher than our forecast.

*Question:*

A few weeks ago, there were citizens in Toronto from Wisconsin, Minnesota, Illinois, Michigan, Ohio etc., and some from Ontario and Quebec, for the annual meeting of the Great Lakes United Organization. I found myself wondering if Rear Admiral Timbrell is aware that that particular group has a very strong position against winter navigation on grounds of the environment. I would be interested in any comments about it.

*Rear Admiral Timbrell:*

I'd like to make three points if I may. The Seaway, as we know it today, opened 25 years ago this year. We are celebrating the 25th anniversary of the Montreal-Lake Ontario section. Since opening day, 25 years ago, the season today is approximately 34 days longer than it was 25 years ago, and I believe, with due respect and caution and care in the operation of our ships and other features, we have protected the environment that we operate in. Secondly, approximately 17 years ago, much to the chagrin of a place I come from called Halifax, Nova Scotia, it was decided to keep the port of Montreal open year round. The excuse at that time was to minimize the flooding of the lower area of the St. lawrence River, as opposed to the commercial aspects of Montreal. But Montreal has been kept open for 17 years every winter. From that, the studies have revealed that the shorelines have not eroded, the environment has not been totally damaged, the flooding has been minimized, and the traffic has kept pace. I believe that, winter navigation, if you choose to call it that, or season extension will grow, but very slowly. Again, I take you back 34 days over 25 years, and we haven't taken your cottages away into the middle of the lake and various other facets, so we will see a steady growth, possibly over another quarter of a century we may see another 15 to 20 days. But it is slow, it's cautious, and it's controlled.

*Question:*

I'm Ray Tobin from Rochester, New York, and I have a question for Mr. McIntyre. Does Ontario Hydro utilize off-peak metering and pricing on electric power?

*Mr. McIntyre:*

I guess the answer is yes, but on a very limited basis. We're just getting into it and offering it to industrial customers and to some of our rural customers. As I say, we're just moving into it.

*Mr. Tobin:*
The reason I asked the question is that 17 years ago, the New York State Public Service Commission granted Rochester Gas and Electric permission to delete the use of off-peak meters. I spoke strongly against that from the standpoint that when you don't encourage off-peak use of electric power, you have to build additional power generation to take care of the peaks. For example, when I had an off-peak meter back in 1967, I had an oversized filtering system on my pool. It had a timer on it so that it ran mainly during the evening, which was the off-peak time. I feel that if there was off-peak metering used, it would encourage people to utilize things more efficiently. Electric power is something that you cannot store, and it has to be generated as you use it.

*Moderator:*
We've run out of time again. Thank you very much. I look around the room and I think it's a real tribute to the speakers on the panel as well as the Conference organizers that at the end of the last panel on the last day of the Conference on such a beautiful occasion in such a beautiful city, we have as many people remaining with us in attendance and interested as we do.

## J. Blair Seaborn

*Commissioner and Chairman of the Canadian Section, International Joint Commission*

# Luncheon Address
# The International Joint Commission and The Water Resources of The Great Lakes

*Mr. Seaborn earned a B.A. degree in Political Science and Economics from the University of Toronto, followed by an M.A. in 1948. For 22 years, he served as a Foreign Service Officer with the Department of External Affairs in The Hague, Paris, Moscow and Saigon, eventually becoming the Head of the Far Eastern Division. In 1970, he was appointed Deputy Minister with the Department of Consumer and Corporate Affairs in Ottawa. From 1974-1982, he served as the Deputy Minister of the Federal Department of the Environment. He has been Commissioner and Chairman of the Canadian Section, International Joint Commission since December 1982.*

After a day and a half of speeches and panel discussion (and a most interesting day and a half it has been for me and my colleagues of the International Joint Commission), I expect that my popularity as a luncheon speaker may be in inverse proportion to the length of time I speak. I shall not seek infinite popularity by saying nothing at all; nor shall I seek zero popularity by speaking indefinitely.

You all know that the International Joint Commission is a Canada-USA institution that deals, primarily, with transboundary waters. It was created by the *Boundary Waters Treaty of 1909* to prevent disputes and to resolve problems which might arise, and indeed frequently had arisen, between the two countries and their inhabitants over the use of their shared water resources. Now over seventy years old, the I.J.C. can probably be regarded in terms of the historic time-span of this continent as venerable (the institution, not its present members) and I suggest that it has a solid record of success.

The men who drafted the Treaty of 1909 were, I believe, more far-sighted than may have been recognized at the time. The impetus for an orderly approach to dealing with common interest in boundary waters sprang from what we might today regard as rather local and small-scale problems. But the principles they enunciated with respect to use of the common resource, be they related to levels and flows or to pollution, and the creation of a binational body to give substance to those principles, constituted one of the most notable examples of transboundary co-operation which exists anywhere. Its language anticipated by six decades the Stockholm Declaration of 1972 which recognized the obligation of all countries in exploiting their resources to do so in a manner which would not do damage to the environment of their neighbours.

Yet, before I get too euphoric, let me say a word about what we are and can do, and what we aren't and can't do.

In one area, we have a quasi-judicial role, a power of decision from which there is no formal appeal. If you want to undertake certain works on one side of the border which would have an effect on the level and flow of water on the other side (for example, a dam or a diversion), you have to make application to the I.J.C. which, after due deliberation, will tell you whether you can proceed and, if so, subject to what conditions. By limiting in this way each country's right to do as it wished with its water resources, the Treaty amounted to a voluntary limitation on sovereignty, but, it also provided that if the two countries could agree directly, that there was mutual advantage in a certain work, then an application to the I.J.C. need not be submitted.

Outside this large area of levels and flows, we do not have powers of decision. We have the responsibility of advising governments, and because our advice is usually made public, you can say that we help bring the weight of informed public opinion to bear on the decisions of government. We can claim, without exaggeration, that our studies and our reports to governments were a significant if not the key contribution to the *Great Lakes Water Quality Agreement* of 1972 and its successor of 1978.

Most frequently, we proffer our advice in response to requests, or "References," from the two federal governments but, unlike Victorian children, we *can* speak without first being spoken to. We have done so rarely, but perhaps we should be bolder, for the governments have encouraged us to do so.

We are usually asked to advise on transboundary water questions, be they of quantity or of quality, or at least questions in the environmental field. But there is nothing in the Treaty which would keep governments from seeking advice from us on other matters of a transboundary nature.

We base our recommendations to governments solidly on the work of technical boards, composed of U.S. and Canadian experts, frequently public servants from the jurisdictions represented here today, who act, as we say, "in their personal and professional capacity". With their access to your data and information, they establish jointly the agreed relevant facts which must constitute the common base for intelligent decision-making.

We have, from the beginning, augmented this technical information with input from the interested and affected public, derived at public hearings. We have not, to my mind, kept up to the latest thinking on consultation with the public, but we were holding hearings well before it was the fashionable standard practice to do so, and we are striving to up-date our procedures.

If reliance on technical boards and broader public input is our usual procedure, it is not exclusively so. We are actively looking to other and more innovative ways to "prevent disputes" and "resolve problems," as the Treaty says. In the Skagit Valley dispute, to use one recent and successful example of innovation, two of our Commissioners played a very determined mediatory, conciliatory and "brokerage" role, reinforced by a Commission-imposed time constraint, to help British Columbia and the City of Seattle find a mutually satisfactory solution to an issue which had plagued relations for decades. The decision is logically, politically and socially defensible. Seattle will get the electric power it needs at an acceptable price over a long term, and British Columbia has avoided the flooding of a valley which had acquired great ecological and recreational importance, a "win-win" situation.

We are currently working on another case which we hope will also have a happy ending—improving the fishery habitat in the St. Marys Rapids near Sault Ste. Marie in a manner that would also increase the amount of water available for hydro-electric power production at Canadian and U.S. power plants.

But what of our work in connection with that incredibly important shared water resource which is the focus of this conference, the Great Lakes?

First, a word about the water quality of the Great Lakes, brief, because I recognize that it is not the main thrust of this gathering. The inter-relationship of water quantity and water quality is such, however, that neither can be totally isolated from the other.

I have already mentioned in passing that the I.J.C. played a significant role in the events leading to the signing of the Great Lakes Water Quality Agreements of 1972 and 1978. For many years, and indeed even before World War II, the I.J.C. had been building up a stronger and stronger case for governments to come to grips with the deteriorating quality of Great Lakes waters. Drawing on a wide range of expertise from federal, state, provincial and academic institutions, the Commission was able to produce agreed data and agreed conclusions, among others, that Lake Erie was on the way to an early demise through eutrophication (Lake Ontario was in some danger also) and that rapid action was needed to reduce the amount of phosphorus entering the lakes if irreversible damage was to be avoided. The result was the *Great Lakes Water Quality Agreement* of 1972.

You may know, as senior representatives of your jurisdiction, what action should be taken with respect to Great Lakes water quality. But I suggest to you that it is easier for you to take that action, and perhaps to persuade reluctant colleagues in your administrations that it is the right action to take, if the recommendation comes from a body which is bi-national, which strives to work in a collegial way and which over the years has built up a reputation for objectivity, fairness and common sense. We think it may be easier for you to accept constructive criticism from the I.J.C. than from certain other quarters. If, as is the case in so much of our work, and certainly in Great Lakes Water Quality, our role is essentially advisory, our advice and our judgement have to be dispassionate, solidly based in fact and even-handed if we are to maintain our credibility and our usefulness, to you and to the people of the two countries. We are very conscious of the fact that our advice has to be politically responsible, something governments can perhaps with some difficulty, live with. We also like to think that if our advice is sound, and is public, it is not easy, or wise, for governments to ignore it.

What does this approach on our part say about the I.J.C. role in the matter of the Great Lakes water levels; about the use of water for non-consumptive uses like navigation and hydro-electric generation and recreation; about withdrawals of water from those shared lakes; about the return to the lakes of withdrawn water in a state inferior to that when it was withdrawn; about its consumption for industrial and energy and municipal and agricultural purposes and its non-return to the lakes; about large-scale diversions of water into or out of or within the Great Lakes basin?

Because of our original and ongoing responsibilities with respect to levels and flows of transboundary waters, we've been heavily involved in many aspects of Great Lakes water quantity from the beginning. When lake levels have been low, we've been asked what should be done to raise them; and when lake levels have been high, we've been asked what should be done to lower them. We've submitted numerous reports on those subjects over the years.

Right now, the Commission is busy preparing another report to the two Federal Governments on water levels in response to a Reference a few years back, but this Reference has a couple of new twists to it. It asked us, as others have done, to look at existing diversions (Chicago, Long Lac-Ogoki, Welland Canal, New York State Barge Canal) and what effect they were having, or by their manipulation could have, on water levels. It also asked us to look at two new things:

a) any federal, state or provincially-sponsored or approved new or changed diversions;
b) existing and reasonably foreseeable patterns of consumptive uses of Great Lakes waters.

I wish our report had been completed and released in time for this meeting so you would be aware of our considered opinions, with all the necessary nuances of wording. It's not quite finished yet, but I think I can give you a sneak preview of some of the information it will contain, and of where at least some of the Commission's thinking is on the matter.

Before that, let me summarize for you the report of our Technical Study Board on Great Lakes Diversions and Consumptive Uses. The report was completed and made public late in 1981 and formed the basis of a series of public meetings held by the Commission in seven Great Lakes cities in June of last year. The gist of that report was as follows:

a) the further manipulation of existing control structures and mechanisms can have comparatively little effect on lake levels, certainly not at an acceptable economic cost, and certainly not in comparison with the effects of natural phenomena;
b) as for new diversions, none has been formally proposed to any level of government;

c) the projection of existing trends of consumption of Great Lakes water, starting from a 1975 base of 4900 cfs, would indicate a consumptive use in the year 2035 of somewhere between 16,000 cfs and 37,000 cfs depending on the assumptions, with a most likely projection of 25,000 cfs;

d) such a consumptive use would significantly lower lake levels, with resultant economic benefits to coastal zone interests and losses to navigation and power interests.

When the Commission held its public meetings last June to hear what interested persons and groups had to say about these questions, we found that, since we were first tasked with the study in 1977, there was a strongly-heightened public interest in what happens to Great Lakes waters, be that by way of possible diversion out of the basin or by its virtually uncontrolled use for energy, industrial, municipal and agricultural purposes. There was a fuller realization that, increasingly, untrammelled use by some was going to have an adverse and limiting effect on use by others, and for other purposes. There was a growing recognition, in other words, that the resource was not and has never been an unlimited one. Some strong statements were made, including one by the Government of Ontario which is hosting this conference

I've given you the essence of the Study Board's report and of what we heard in our public meetings. Where is the Commission likely to come down?

As I said earlier, our report is not yet completed, so what I say now will have to be said on my own authority, as one of the six Commissioners. But I shall be surprised if it differs materially from what our report in its final form, in much greater detail and more formally, will say.

First, existing major diversions into, out of and within the Great Lakes basin (some of them pre-dating the Boundary Waters Treaty of 1909). We'll recognize that these have had some measurable effect on lake levels but that it is small in comparison with the natural ranges on the lakes. You could play around with the existing diversion rates and have some effect on high water levels (not much on low water levels) but probably at net economic loss. So this line of thought is not very productive.

Secondly, major new diversions or major increases in existing diversions, even if at present they have no governmental support. At our hearings and elsewhere, we heard about, and we continue to hear a great deal of comment about, a possible major diversion into the Great Lakes by re-directing the waters that now flow into James Bay; about the purportedly heavy use of Great Lakes waters for coal slurry purposes; about the growing concern over the reduced water supplies in the "sun belt" of the United States Southwest, heavily dependent on the Ogallala aquifer, and the possibility of directing Great Lakes waters to meet the needs of the people and the industries there.

Let's dismiss the coal slurry bogeyman first. Coal slurries require very small amounts of water in comparison with the amounts of existing diversions. The most likely of the schemes currently envisaged is not going to lead to a net consumption or even any consumption of Great Lakes water.

As for the diversion from the James Bay rivers, or the Grand Canal scheme as it is called, it is highly imaginative and is based on proven engineering technology. But until much more rigorous costing has been done and until serious studies have been undertaken on the environmental impacts and the social impacts on the residents of the James Bay watershed, I for one do not consider it as something on which the Commission can make meaningful comment.

The greatest popular concern with respect to diversions is that a parched U.S. South-west will seek to slake its thirst by a major diversion of waters derived ultimately from the Great Lakes. If you look to the economics of this one, you'll find that the cost of the resultant diverted water will be such as to make it prohibitively expensive for all but the most exotic uses. Yes, I know that water flows uphill to where money is; but this one would require such a mammoth expenditure of public funds as to give pause even to the most enthusiastic proponent. I say this even in the historic context of public subsidization of water supply in both our countries, which has not always been characterized by the most hard-nosed regard for costs and benefits. Nevertheless, I foresee that a number of changes in water use, a conservation approach, basically, are likely to be made and indeed are being made in that part of the United States such as to reduce the demand for water. Under existing and reasonably foreseeable circumstances, I do not regard as a likely possibility a major diversion from the Great Lakes to that part of the continent. Certainly it could not be justified on the basis of enabling the residents and industries of the area to go on using water as they have used it in the past.

Thirdly, consumptive uses. Our Technical Board made its projection of future trends, through to 2035, on the basis, of course, of data and information available to it in the period up to 1980 or so, and on the basis of assumptions of an economic and technological nature which seemed reasonable at that time. Their projections looked at extremes, both high and low, which bracketed a median "most likely projection." The resultant impacts on Great Lakes levels, under the most extreme scenario and even under the most likely projection, are pretty scary: a drop in Lake Ontario's level by, say, one foot is not something to take lightly.

Re-examining those assumptions and data currently available would certainly lower the projections of growth rates and therefore water consumption. The energy sector and particularly the nuclear energy sector was the largest contributor to the expected increase.

You all know what has happened to changed projections, over the last few years, of energy use, not to mention the expected reduction in the proportion of energy from nuclear sources in the USA, thanks to changing economic conditions and to major efforts of energy conservation for cost and other reasons. A similar but less well documented change in the projections for water consumption by industry, especially heavy industry, would lead to more conservative expectations for consumptive use there, thanks to technological change, and the lesser importance of heavy industry in our economies as a whole. And finally, the Commission now tends to question the feasibility of projections as far ahead as 2035, given the rapid variability of so many of the assumptions about economic growth and technological change.

All this leads us to think that the Board's most likely projection of a doubling of Great Lakes water consumption by the year 2000 (I leave aside a five-fold increase by 2035) is probably on the high side, and would be brought down significantly in the light of today's data and information. Does this mean we can relax and forget all about it? I don't think so. The likely increase in consumptive use should be no cause for present panic, but it's still significant enough that we should at minimum be monitoring it so we may know exactly what is happening, not relying on estimates and projections.

We should also, it seems to me, I speak now as a concerned citizen, be insisting that our governments set up a forum within thich they can regularly and systematically discuss what *is* happening to Great Lakes water; what the trends are; and what mechanisms might be put in place, in a timely manner, to ensure that our shared use of Great Lakes water takes place in a rational and equitable manner. Governments should be striking the balance among the interests of such diverse users as the riparian land holder, the recreational boater, the energy industry (both hydro and thermal) and navigation, taking into account the advantages which all of us as individuals derive from these several uses. They have a special responsibility to ensure that the priceless inheritance of shared water resources such as Great Lakes water are available for users in both countries in future generations.

It seems to me also that, if governments are to approach the question responsibly, they will have to look more widely than even the basin of the Great Lakes and its interests. As we become more aware of fresh water as a resource, a fundamental resource, on which depends so much of our economic development, our life-style, our very existence, governments will be obliged, I believe, at the national level, to identify the resource and to develop strategies for its wise management over the long term. In the course of so doing, they will have to tackle such touchy and difficult questions as to whether we can continue to treat water essentially as a "free good" or whether it will have to come under some regulation over its use by pricing or other mechanisms; as to whether there are certain conditions under which major diversion of waters into or out of the Great Lakes might be to our mutual advantage in Canada and the USA; and as to what is, in contemporary terms, an equitable sharing of the waters of the Great Lakes among the many users in both countries. They will have to do so in full recognition that the Great Lakes are much more than of economic interest; they are part of our continental heritage and part of an ecosystem of which man is only one element.

Time does not permit me to do more than make the briefest mention of two other considerations which could impact on Great Lakes water and its use. First, climatological change, especially the so-called "greenhouse-effect" as a result of the build-up of $CO_2$ in the atmosphere and the expected increase of temperatures, can lead to increased evaporation and decreased runoff and decreased outflows in the Great Lakes area. It may also lead to increased demand for water in other parts of the continent. Secondly, a world shortage of food due to population increases and degradation of agricultural land elsewhere on the globe may put extra pressures on North America for food production and thence on current estimates as to what is a reasonable diversion of water for food production purposes.

These are the concerns our report is trying to come to grips with. My hard-headed fellow Commissioners and indeed many in this audience may be somewhat uncomfortable with this sort of conjecture. Do not count on it, therefore, that all that I have alluded to, admittedly in some respects in simplistic terms, will appear in the I.J.C. report to Governments. I suggest to you most strongly, however, that the governments and citizens of our two countries are going to have to start thinking in these terms, and to open their minds to a range of possibilities for the future, perhaps some considerably different from the recent past, if they are to accept their full responsibilities with respect to "Futures in Water."

## Concluding Remarks—

*The Honourable Alan W. Pope*

Thank you very much, Mr. Seaborn, for your remarks and for updating us on the expected report of the International Joint Commission. I would beg your indulgence to just very briefly, in the space of just less than 10 minutes, give some concluding remarks and some indication of where we're going to go from here.

I would first of all like to thank Tony (Clarke) and Dave (Strelchuk) and all of the people from the Ministry of Natural Resources of Ontario, from the Ministry of the Environment of Ontario, the Intergovernmental Affairs Department of the Ontario Government, the Premier's Office, from External Affairs Canada, Environment Canada, and many other Branches of the Federal Government who assisted us in the organization of this Conference.

I would particularly like to thank the distinguished men and women from across Canada and the United States who have spoken to us yesterday and today. I think you'll all agree that we've heard from a first class group of speakers, and I think each one of them has brought an interesting and unique point of view to this Conference. So I would like to again thank all of them and all of you for coming to "Futures in Water". As we have heard throughout this Conference, the issues of water consumption and diversion are emerging ones and, in a sense, the concerned men and women in this audience are the pioneers who will have to stimulate dialogue in these very important issues. A dialogue which I hope will lead to a better appreciation of our water resources and better water management in the years to come. I think each of us now has a responsibility, as Sally Barnes said in her remarks yesterday, to pass the word along that water quantity is indeed an issue everyone in Ontario, and indeed throughout North America, should be deeply concerned about. Each of you here and each of you who has participated and been in attendance has helped to make this Conference a success, both in terms of what we have accomplished as well as in terms of media coverage. As you know, we have attracted a great deal of media interest in both Canada and the United States over the past few days, and we all know how very important that is. For the media performs an invaluable function in informing the public on issues of great public concern. Hopefully, the media's interest, as well as our own, will intensify in the months ahead.

As I look back over the last couple of days, I find I'm left with several key ideas as no doubt all of you are. I would like to share a few of my own with you.

Paul Robinson does not expect the water-short states to clamour for Great Lakes water for 30 to 50 years, if ever. We have heard from a number of speakers, on the other hand, including former Governor Milliken, Governor Scott Matheson of Utah and Ben DeCooke, that there could be high pressure in these regions for our water.

I was pleased to hear Governor Matheson emphasize the necessity for conservation and small-scale water supply projects as well as his remarks concerning the unlikelihood that large-scale diversion projects would ever receive, at least in the foreseeable future, adequate government funding. However, as the Governor indicated in his last paragraph, these remarks are not any cause for complacency on our parts.

We've heard from Governor Matheson as well that the days of big dam building projects are over. We've also heard about the State of Arizona buying farmland to reduce water use there. Now, we've heard various alarming reports on the Ogallala Aquifer—as Governor Milliken said, optimists give it a life expectancy of 40 years; pessimists a life expectancy of 8. Although as a number of speakers pointed out, no state governments are now calling for a diversion of Great Lakes waters, I don't think that this will always be the case. This morning, Senator Durenberger certainly confirmed this point of view that we should not be complacent because, as he quite clearly said, water is a political commodity. He indicated his feeling that there hadn't been a rational approach or a rational economic policy towards the use of water in the United States. He also indicated that the cost of water has never been a barrier to its development and interbasin transfer. And I think, most importantly, that as well as a policy issue on the Federal, state and provincial levels, there was an emerging consensus or body of legal opinion and correct precedent in the United States which indicated that there were private-sector interests and economic commodity interests that were above and beyond the Federal, state and provincial policy-makers. And, just at lunch today, Mr. Seaborn in his excellent address indicated to us what may be the final detail of the Report of the International Joint Commission on Water Quantity issues. He made reference to the Grand Canal System. He made reference to the rationale of opposing diversions on the basis of cost and other justifications. He indicated what might appear in the Final Report with respect to Consumptive Uses update with less development projected than the Working Papers had indicated, perhaps a doubling of consumption by the year 2000, and he also added that there is some significance to the suggestion of the greenhouse effect relating to water levels in the Great Lakes states.

Clearly, as Premier Davis and many speakers pointed out, we need to continue to work closely with our American neighbours, the Federal Government, the Province of Quebec and the people of the United States and Canada to forge, first and foremost, a Great Lakes regional consensus in finding ways to strengthen our position with respect to diversions and also to develop basin-wide approaches to reduced consumption. Perhaps one solution, as Dr. Bruce Mitchell suggested, is to establish a more realistic pricing of water as he said, and I quote "One wonders if we would have such a complacent attitude towards water if it were priced to reflect its actual value." When a good is under-valued, it tends to be over-used.

Mr. Seaborn today, and certainly Senator Durenberger, emphasized that point of view. Then again, perhaps one solution to all our problems could someday lie in some of the large-scale proposals made by such men as Thomas Kierans. But who can say, at this point in time? Yesterday at lunch, Jim Bruce certainly gave us food for thought when he discussed the possible future changes in the climate brought on by the greenhouse effect, and I am pleased to see that the I.J.C. is considering that matter. That matter and the ways in which the greenhouse effect could detrimentally reduce our water supplies. I think each one of us individually has a great deal to digest from this Conference and I think, if there is some common consensus that we'll all leave "Futures in Water" with, it is that we need to learn more about our own and each other's water practices; we need to communicate as often as possible at forums such as "Futures in Water", and we need to work together to find common approaches and solutions to our many water quantity concerns.

Where do we go from here? I think it's important that we keep in touch with one another, that we strengthen the relationships that have been formed here. We will be sending you a list of the delegates and their addresses, and we intend to keep in touch with you. Proceedings on this Conference will be bound and sent to all delegates. We are also producing a one-hour video tape presentation on this Conference that will be made available on loan for information and educational purposes in the near future. And I would like to encourage each and every one of you to expand your own networks, whether you are from the academic world or a conservation group or the shipping industry or whatever. I urge you to talk to your colleagues in your own and other regions of North America to get more people involved in this issue, and we will look to each of you for advice in the months and years to come on common policies that all Great Lakes jurisdictions, state, provincial and federal, should start to consider.

I hope that we in Ontario and others in the Great Lakes region will hold other symposia and workshops on water quantity in the future. Ontario will be attending National Water Alliance and Governors meetings throughout the United States. I would like to suggest that we should all meet, perhaps again next year, to examine our progress that we have made together. Perhaps such a meeting could be held in one of our neighbouring states.

In closing, I would like to thank each of you again for coming to "Futures in Water", for your participation, for your contributions and, most importantly, for your concern. As I mentioned earlier, I think that you are representatives of a group of concerned individuals who we know are out there throughout the Great Lakes Region and across North America. The concern we share carries with it a great responsibility for the future to inform to interest and excite others in this most serious issue.

An important initial step in Ontario has been taken at this Conference, and public awareness in the issue is greater today than it was at the beginning of the week. I intend, and the Ontario Government intends, to do its best to ensure that this is only the beginning. And I would ask you all to do the same.

Thank you very much, have a safe trip home, and God Bless.

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